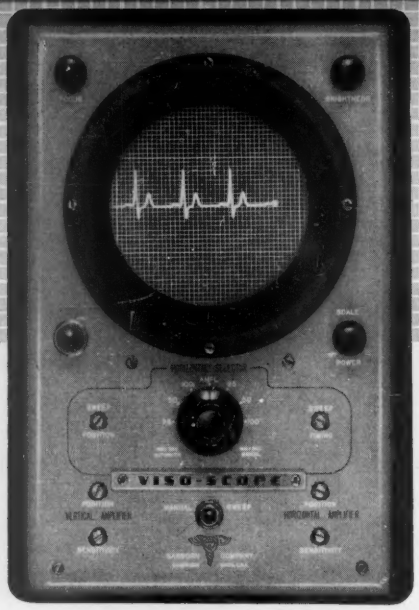
SCIENCE

20 July 1956

Volume 124, Number 3212

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FOR CONTINUOUS VISUAL MONITORING OF PHYSIOLOGICAL EVENTS



MODEL 169A
VISO-SCOPE

DESIGNED for compatibility with other SANBORN equipment (examples, right) and simplified operation via minimum controls (illustration, above), the Model 169A Viso-Scope now permits the owner or purchaser of SANBORN recording instruments to greatly widen their field of usefulness.

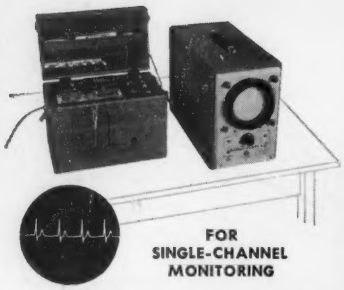
The cathode ray tube selected for this 'scope has a *dual coating* which produces a beam image of exceptional sharpness and long persistence on the orange screen-filter (when monitoring) and of extreme brightness and short duration on the blue screen-filter (for photography). When photography is desired, a Fairchild or DuMont oscilloscope camera may be mounted on the screen bezel (or any common camera may be used).

Sweep speeds of 25, 50 and 100 millimeters per second are obtainable instantaneously, and enlargement on the Viso-Scope screen of a segment of the tracing which is of particular interest may be made at any time.

Typical applications of the Viso-Scope include: observation of changes in the electrocardiogram resulting from use of drugs; pressure monitoring in catheterization during manipulation of the catheter; and a more precise study of complex wave forms by an instantaneous increasing of the sweep speed, such as in myography, phonocardiography, and small animal electrocardiography.

Descriptive literature on the Viso-Scope complete with diagrams showing hook-up requirements of various Sanborn recorders is available on request.

The Model 169A-OR (Operating Room) Viso-Scope is a completely self-contained oscilloscope-amplifier unit, specially designed for visual ECG presentation during surgery in the presence of explosive gases. Viewing unit is supported at or above five foot height on a steel column, and may be turned and tilted for best viewing angle. Provision is made for connection to a remote ECG, when written records are also desired.



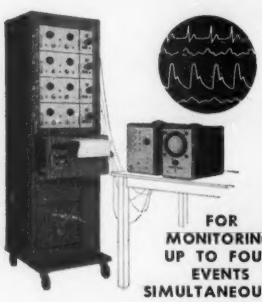
FOR SINGLE-CHANNEL MONITORING

Electrocardiograms may be continuously monitored with a Viso-Scope connected directly to a Sanborn Viso-Cardiette (Model 572 or 51). Or, a Model 128 or 141 Sanborn Recorder may be similarly used for viewing other phenomena such as pressure, temperature, sphygmograms, pneumograms, myograms, etc., with suitable transducers employed.

Written records may be made whenever desired during the monitoring. Selection of sweep speeds on the Viso-Scope is particularly advantageous to owners of these instruments.

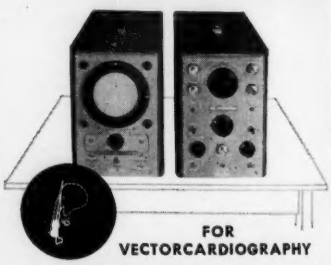
FOR HIGHER SPEED MONITORING

With the addition of an attachable booster amplifier the Viso-Scope may be used with a Sanborn Twin-Beam Cardiette, to display phenomena of higher frequency such as are encountered in phonocardiography, small animal electrocardiography, high fidelity human electrocardiography, etc. Separate oscilloscope jacks on the Twin-Beam permit ready selection of the signal from either "phono" or ECG channel, for alternate display on the Viso-Scope screen.



FOR MONITORING UP TO FOUR EVENTS SIMULTANEOUSLY

The Sanborn Electronic Switch, shown above connected to each channel of a Model 154M four-channel Poly-Viso, is designed for use with any Sanborn two-or four-channel *direct writing* recording system. It permits *simultaneous* observation of as many phenomena as the system is set up to record, and a Viso-Scope thus connected appears to be operating with *separate beams*. Controls permit liberal relative positioning of beams on the scope screen, and *individual* sensitivity control. These adjustments have no effect on the recording instrument.



FOR VECTORCARDIOGRAPHY

The Sanborn Model 185 Vector System (or vector amplifier) shown above right, has been specifically designed for use with the Viso-Scope, for displaying either vector loops or ECG complexes. This instrument's lead selector switch, together with a specially-marked 9-wire patient cable and extra electrodes, permit the instantaneous selection of either cube or tetrahedral vector leads, or ECG leads, for Viso-Scope display. Adequate sensitivity (10" per mv) provides clear showing of P and T loops, as well as QRS. Additionally (via installation of timing transformer in the Viso-Scope) the Vector system provides Z axis, or intensity modulation for indication of speed and direction of sweep trace.

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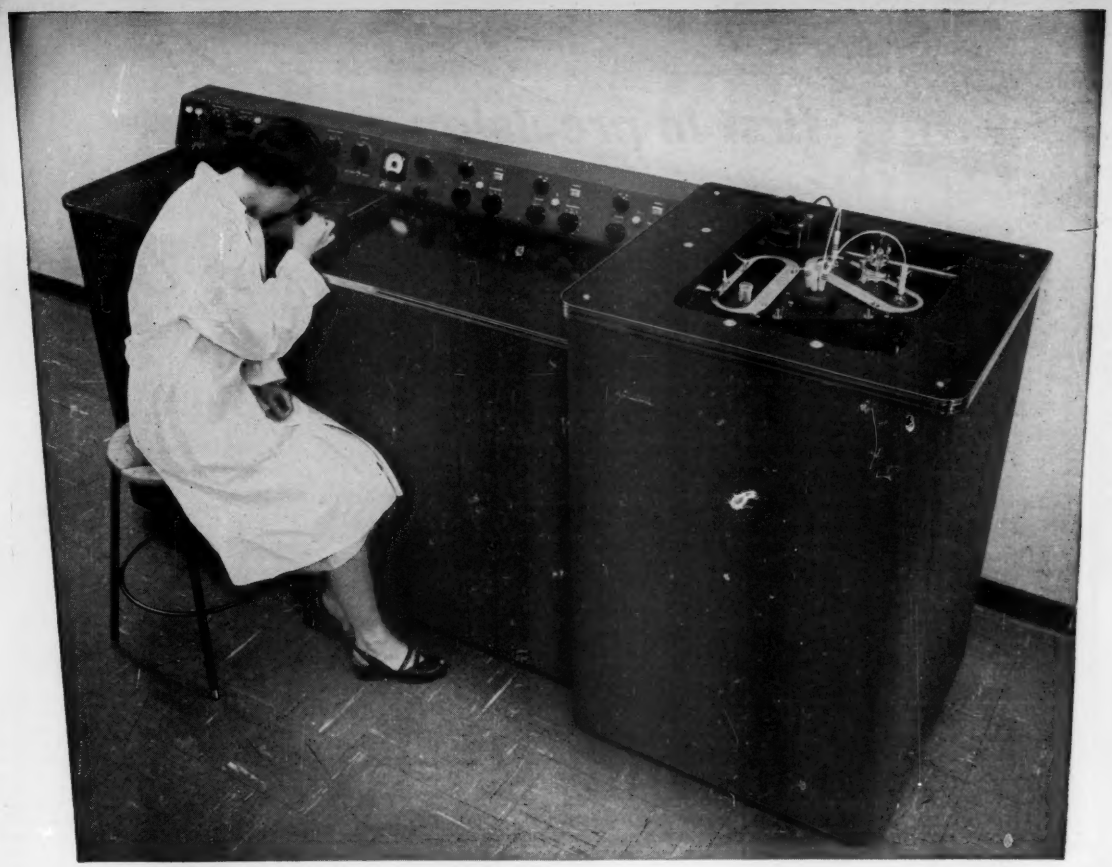

Spinco Model H Electrophoresis-Diffusion Instrument

Electrophoresis-Diffusion facilities for high-precision research uses are combined in the Spinco Model H Electrophoresis-Diffusion instrument, illustrated. Having multiple optical systems arranged for rapid and efficient use, an optimum of automatic controls, and a single-unit construction, the instrument features ease and convenience of operation

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Radiation and Public Knowledge

The simultaneous release of the summary reports of the U.S. National Academy of Sciences study on the *Biological Effects of Radiation* [*Science* **123**, 1157 (29 June 1956) *et seq.*] and the report of the Medical Research Council of Great Britain on *Hazards to Man of Nuclear and Allied Radiations* (*see* p. 112) is a welcome event. It is encouraging to note that the major recommendations of both committees, which, so we understand, worked quite independently, are notably similar.

Both studies were especially concerned with possible genetic damage during the reproductive period of the first 30 years of life, and both calculated the accumulated radiation to the gonads during this time. The estimates of such radiation in roentgen units follow in the order American, British: average background (or natural) radiation—4.3, 3; medical and dental x-rays—3, more than 0.67; fallout radiation on the assumption that the present rate of weapons testing continues—0.02–0.50, 0.26. The only considerable difference is in the estimated absorption of x-radiation, which probably reflects differences in practice in the two countries.

Both committees raised the question of how much of an increase in radiation it would take to bring about a doubling of the mutation rate in man. The American estimates ranged from outer limits of 5 to 150 roentgens over a 30-year span, with the best estimates of several experienced geneticists lying in the range from 30 to 80 roentgens. The British estimates were closely similar, with the outer limits ranging from 15 to 150 roentgens and the best estimate precisely the same as that of the Americans: 30 to 80 roentgens. This agreement is perhaps not as astonishing as it might seem at first glance to be, for both groups had to base their judgments on the same rather limited body of data on mutation rates.

The reports are parallel in other ways: both emphasize the need for more research, both are directed to the public, and both stress the tentative nature of the conclusions and recommendations. The reports differ slightly in their attitude toward genetic damage. The American study takes a somewhat graver view of the long-term effects of increased radiation. In relation to fallout, for example, the Americans, although stating that the dose is ". . . a small one as compared with the background radiation, or as compared with the average exposure . . . to medical x-rays," emphasize the point that all radiation is damaging, while the British take the view that the present hazards from fallout are "negligible."

These reports are, it seems to us, also remarkable documents in that the committees in both countries have made a valiant and, we think, successful effort to make the fundamental scientific bases for understanding their recommendations clear to the educated public. Both reports put an emphasis on the weighing of values that should govern future decisions about the control of radiation. The inevitable adverse influence of increased radiation on health and on the genetic endowment of man must be balanced against the needs for defense and for additional sources of power.

In democracies, an informed public opinion should influence ultimate decisions on weapons testing, atomic power, radiological diagnoses, and other biological hazards of an atomic age. These notable studies have made an informed public opinion possible.—G. DuS.

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Detection of the Free Neutrino: a Confirmation

C. L. Cowan, Jr., F. Reines, F. B. Harrison,
H. W. Kruse, A. D. McGuire

A tentative identification of the free neutrino was made in an experiment performed at Hanford (*1*) in 1953. In that work the reaction

$$\nu_- + p^+ \rightarrow \beta^+ + n^0 \qquad (1)$$

was employed wherein the intense neutrino flux from fission-fragment decay in a large reactor was incident on a detector containing many target protons in a hydrogenous liquid scintillator. The reaction products were detected as a delayed pulse pair; the first pulse being due to the slowing down and annihilation of the positron and the second to capture of the moderated neutron in cadmium dissolved in the scintillator. To identify the observed signal as neutrino-induced, the energies of the two pulses, their time-delay spectrum, the dependence of the signal rate on reactor power, and its magnitude as compared with the predicted rate were used. The calculated effectiveness of the shielding employed, together with neutron measurements made with emulsions external to the shield, seemed to rule out reactor neutrons and gamma radiation as the cause of the signal. Although a high background was experienced due to both the reactor and to cosmic radiation, it was felt that an identification of the free neutrino had probably been made.

Design of the Experiment

To carry this work to a more definitive conclusion, a second experiment was designed (*2*), and the equipment was taken to the Savannah River Plant of the U.S. Atomic Energy Commission, where the present work was done (*3*). This work confirms the results obtained at Hanford and so verifies the neutrino hypothesis suggested by Pauli (*4*) and incorporated in a quantitative theory of beta decay by Fermi (*5*).

In this experiment, a detailed check of each term of Eq. 1 was made using a detector consisting of a multiple-layer (club-sandwich) arrangement of scintillation counters and target tanks. This arrangement permits the observation of prompt spatial coincidences characteristic of positron annihilation radiation and of the multiple gamma ray burst due to neutron capture in cadmium as well as the delayed coincidences described in the first paragraph.

The three "bread" layers of the sandwich are scintillation detectors consisting of rectangular steel tanks containing a purified triethylbenzene solution of terphenyl and POPOP (*6*) in a chamber 2 feet thick, 6 feet 3 inches long, and 4 feet 6 inches wide. The tops and bottoms of these chambers are thin to low-energy gamma radiation. The tank interiors are painted white, and the solutions in the chambers are viewed by 110 5-inch Dumont photomultiplier tubes connected in parallel in each tank. The energy resolution of the detectors for gamma rays of 0.5 Mev is about 15 percent half-width at half-height.

The two "meat" layers of the sandwich serve as targets and consist of polyethylene boxes 3 inches thick and 6 feet 3 inches by 4 feet 6 inches on edge containing a water solution of cadmium chloride. This provides two essentially independent "triad" detectors, the central scintillation detector being common to both triads. The detector was completely enclosed by a paraffin and lead shield and was located in an underground room of the reactor building which provides excellent shielding from both the reactor neutrons and gamma rays and from cosmic rays.

The signals from a bank of preamplifiers connected to the scintillation tanks were transmitted via coaxial lines to an electronic analyzing system in a trailer van parked outside the reactor building. Two independent sets of equipment were used to analyze and record the operation of the two triad detectors. Linear amplifiers fed the signals to pulse-height selection gates and coincidence circuits. When the required pulse amplitudes and coincidences (prompt and delayed) were satisfied, the sweeps of two triple-beam oscilloscopes were triggered, and the pulses from the complete event were recorded photographically. The three beams of both oscilloscopes recorded signals from their respective scintillation tanks independently. The oscilloscopes were thus operated in parallel but with different gains in order to cover the requisite pulse-amplitude range. All amplifier pulses were stored in long low-distortion delay lines awaiting electronic decision prior to this acceptance.

Manual analysis of the photographic record of an event then yielded the energy deposited in each tank of a triad by both the first and second pulses and the time-delay between the pulses. Using this system, various conditions could be placed on the pulses of the pair comprising an acceptable event. For example, acceptance of events with short time delays (over ranges up to 17 microseconds, depending on the cadmium concentration used) resulted in optimum signal-to-background ratios, while analysis of those events with longer time delays yielded relevant accidental background rates. Spectral analyses of pulses comprising events with short time delays were also made and compared with those with long delays.

This method of analysis was also employed to require various types of energy deposition in the two tanks of a triad. For instance, the second pulse of an event

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could be required to deposit at least a given energy in each tank, and in addition, maximum and minimum limits could be placed on the total energy of the pulse. Application of criteria such as these assisted in discriminating between events satisfying the physical aspects of a neutrino capture and the various backgrounds experienced. Simultaneous presentation of the three tank outputs on the three beams of the oscilloscopes also permitted rejection of pseudo events due to penetrating cosmic rays, thus utilizing the two triads as shields for one another.

The varying rates observed by changing the response of the system assisted in ascertaining that the gamma rays observed did indeed arise in the target tanks. The efficiency of the system was calibrated in each case by the use of a dissolved copper-64 positron source in the target tanks and by using a plutonium-beryllium neutron source. The neutron calibrations utilized the 4.2-Mev gamma ray emitted by the source as the first pulse of a delayed pair, the second being due to capture of the associated neutron in the cadmium. In addition, secondary calibrations were performed each week using the cosmic ray penetration pile-up peak (7) and standardized pulsers to check for drift in the apparatus. Standard pulses were recorded each day on the oscilloscope cameras to maintain a constant film calibration. Running counts were made of all single and prompt coincidence rates relevant during the experiment as checks for drift or changes in background. Long-term stability of the equipment was easily maintained, and the results of the two independent triad detectors agreed well throughout the experiment.

Experimental Results

Using this equipment near one of the reactors at the Savanaah River Plant, the following results were obtained bearing on the reaction expressed by Eq. 1.

1) A reactor-power-dependent signal was observed which was (within 5 percent) in agreement with a cross section for reaction 1 of 6.3×10^{-44} cm^2. The predicted cross section (*8*) for the reaction, however, is uncertain by ± 25 percent. In one set of runs, the neutrino signal rate was 0.56 ± 0.06 count per hour, and with changed requirements it was 2.88 ± 0.22 counts per hour. The total running time, including reactor-down time, was 1371 hours. The signal-to-backgrourd ratio associated with the higher signal rate quoted was about 3 to 1. The neutrino signal was greater than 20 times the accidental background associated with the reactor.

2) A signal rate produced by reaction 1 must be a linear function of the number of protons provided as targets for the neutrinos. This was tested by diluting the light water solution in a target tank with a heavy water solution to yield a resultant proton density of one-half of normal. The neutron detection efficiency measured using the plutonium-beryllium source was essentially unchanged. The reactor signal fell to one-half of its former rate.

3) Reaction 1 states that the first pulse of a delayed pair observed must be due to the annihilation radiation of a positron in the target tank. This would produce one ½-Mev gamma ray entering each detector tank of the triad simultaneously after some degradation in the water target. Events were thus chosen which satisfied these time and spatial conditions. Analysis of the pulse-amplitude spectra of these gamma rays associated with short time-delay events yielded spectra which matched that produced by the dissolved copper-64 source, having a peak at about 0.3 Mev. Spectra obtained for the first pulse of events with long delays (accidental events) were, on the other hand, monotonically decreasing with energy, as was the background spectrum producing the accidental events.

A differential absorption measurement was made using first a 3/16-inch and then a ⅜-inch-thick lead sheet between the target tank and one scintillation tank of a triad. The measured neutron detection efficiency was changed to about 70 percent of its former value in the first case and to about 45 percent in the second. The reactor signal rate fell sharply, however, as required for events with first pulse gamma rays of 0.5 Mev originating in the target tank.

4) The second pulse of the delayed pair signal observed was identified as being due to the capture of a neutron by cadmium in the water target. In addition to the prompt spatial coincidence required and the total-energy limits of 3 to 11 Mev imposed on a pulse for acceptance, analysis of the time-delay spectrum yielded excellent agreement with that expected for the cadmium concentration used in the target water (7). Doubling of the cadmium concentration produced the expected shift in the time-delay spectrum without increasing the signal rate. Removal of the cadmium from the target water resulted in disappearance of the reactor signal.

5) As it is possible for a fast neutron or energetic gamma ray entering the detector from the outside to produce pseudo events with many of the characteristics of true neutrino captures, the observed reactor signal was tested for these effects. A strong americium-beryllium neutron source was used outside the detector shield to produce pseudo signals. Tests of the pseudo signal with the lead sheet described in paragraph 3 resulted in a negligible drop in rate beyond that accounted for by the lowered neutron detection efficiency mentioned in paragraph 3, in contrast with the strong response of the reactor signal. The spectrum of first pulse amplitude of the neutron-produced signal with short time delays fell monotonically with increasing energy, in contrast with the characteristic spectra obtained with both the reactor signal and the dissolved copper-64 positron source.

The results of the heavy water dilution measurement described in paragraph 2 also militates against reactor-produced neutrons or gamma rays as the agent producing the signal observed.

Finally, a gross shielding experiment was performed in which the detector shield was augmented by bags of sawdust saturated with water. When stacked, the density of the added shield was 0.5 grams per cubic centimeter, its minimum thickness was 30 inches, and its average thickness was about 40 inches. This absorber would reduce the signal caused by neutrons to about one-tenth of its former rate, depending somewhat upon the direction of the incoming neutrons, and would produce a similar decrease in a signal caused by gamma rays. No decrease was observed in the reactor signal within the statistical fluctuations quoted in paragraph 1.

References and Notes

1. F. Reines and C. L. Cowan, Jr., *Phys. Rev.* **90**, 492 (1953); **92**, 830 (1953).
2. C. L. Cowan, Jr. and F. Reines, invited paper, American Physical Society, New York Meeting, Jan. 1954; The results of the present work were presented in a Post deadline paper, American Physical Society, New Haven Meeting, June, 1956.
3. We wish to thank the many people at the Los Alamos Scientific Laboratory who assisted in the preparation of the experiment and to mention especially A. R. Ronzio, C. W. Johnstone, and A. Brousseau for their help in the chemical and electronic problems. M. P. Warren and R. Jones were invaluable members of the group during both the preparation and field phase of the problem. We also wish to thank the E. I. du Pont de Nemours Company and their personnel at the Savannah River Plant for their constant cooperation and assistance during our stay at the reactor. This work was performed under the auspices of the U.S. Atomic Energy Commission.
4. W. Pauli, in *Rapp. Septieme Conseil Phys. Solvay, Brussels 1933* (Gautier-Villars, Paris, 1934).
5. E. Fermi, *Z. Physik* **88**, 161 (1934).
6. Triethylbenzene scintillator, studied first in connection with the Hanford experiment in the search for higher proton densities, was purified by methods developed in collaboration with A. R. Ronzio. POPOP, a scintillation spectrum shifter, was developed by F. N. Hayes. Hayes, Rogers, and Ott, *J. Am. Chem. Soc.* **77**, 1950 (1955).
7. F. Reines, *et al.*, *Rev. Sci. Instr.* **25**, 1061 (1954).
8. This value for the predicted cross section is calculated from the decay of the neutron as observed by J. M. Robson [*Phys. Rev.* **83**, 349 (1951)] and the spectrum of beta radiation from fission fragments as measured by C. O. Muehlhause at Brookhaven National Laboratory. We are indebted to Muehlhause for communication of his results in advance of publication.

Meteorological Aspects of Atomic Radiation

Nuclear weapons produce atomic clouds which rise to heights dependent principally on the energy released and also on the type of burst (air, surface, underground, and so forth). Weapons in the kiloton range leave most of their radioactive debris in the troposphere, while megaton weapons are powerful enough to inject significant quantities of radioactive material into the stratosphere. Once the debris is injected into the atmosphere, it is rapidly spread over the earth by atmospheric processes, and eventually deposited on the surface of the earth, in a complex manner. Among the many problems are included (i) the way in which debris is mixed and transported by the atmosphere, both vertically and horizontally; (ii) the mechanism of removal from the troposphere and deposition on the ground; and (iii) the rate of penetration from the stratosphere through the tropopause and into the troposphere for eventual removal.

Categories of fallout. The problem of the removal of radioactive debris from the atmosphere and its deposition in the biosphere may be divided into three phases: (i) early or "close-in" fallout—that which occurs within the first 10 to 20 hours following a nuclear explosion; (ii) intermediate fallout—that which occurs during the first weeks following the burst; and (iii) delayed fallout—the slow removal of small particles which may continue for months and even years, particularly after a high-yield thermonuclear explosion.

The principal mechanisms by which the removal occurs are gravitational settling, scavenging of radioactive particles by falling precipitation, and deposition by diffusion resulting from the ever-present turbulent eddies of the atmosphere. Although all principal mechanisms of removal play a role in each phase of the fallout, the primary emphasis shifts from gravitational influences in the early fallout to precipitation scavenging in the intermediate phase to an as yet poorly understood combination of diffusion and scavenging in the delayed fallout.

Measurements. The most direct measurement of radioactive deposition is that made from the soil since it represents the main natural surface onto which the particles fall. Difficulties arise from the fact that rain may remove some of the activity by runoff or soaking deeper into the ground. As a measure of the true radioactivity on the ground in determining plant or animal intake of strontium-90, for example, soil sampling is obviously the most acceptable solution. But, for an accounting of the amount which has been deposited, the soil analysis may be unsatisfactory if the sampling is performed, at say, yearly or multiyearly frequency. Soil sampling on a frequent basis may be impractical.

Measurement of radioactivity by use of hand monitoring equipment is standard practice in areas where the radioactive deposition is significantly above normal background. This kind of observation is almost entirely useless outside of the areas of close-in fallout.

For daily, weekly, or monthly fallout collections, the New York Operations Office of the U.S. Atomic Energy Commission recommends the use of a 1-square-foot sheet of gummed film mounted horizontally on a stand 3 feet above the ground. An extensive, worldwide network of daily gummed film collection at about 250 locations has been operated by the AEC for several years.

Finally, since there is evidence that much of the radioactivity deposited outside of the close-in area is brought down in precipitation, the collection of whole water samples is a method of obtaining the radioactivity of particles.

Measurement of air concentration near the earth's surface has been achieved by a variety of sampling procedures. Filtration equipment of many types has been successfully employed, but the efficiency of the filter material for various particle sizes, particularly in the submicron range, must be determined before quantitative interpretation of the data can be made.

The fact that the upper atmosphere contains significant atomic debris has been known for several years. Sampling of the upper air by aircraft has been achieved by using the motion of the aircraft to pass air through a filter paper. The British report the presence of fission products at the peak altitude of their aircraft, 48,000 feet. The Japanese have measured the radioactivity by carrying aloft Geiger counters on balloons. By subtracting the cosmic ray counts from the total, the remainder is ascribed to fission products. American scientists do not view this procedure with favor for the low levels of radioactivity found over most of the world.

Instrumentation for the measurement of radioactivity by its effects on the electric properties of the atmosphere also are of use only in those regions where the fission-product concentrations are comparatively high.

Close-in Fallout

Close-in fallout is the radioactive material from an atomic explosion which is deposited on the ground within a few hundred miles of ground zero, and which is down in some 10 to 20 hours.

There is a fundamental difference between the fallout from an atomic device detonated at the ground and the fallout from one detonated so high that the fireball does not touch the ground. In the case of the surface burst, large quantities of surface material are broken up, melted, and even vaporized, and some of this material comes in intimate contact with the radioactive fission products. Then, after the atomic cloud has stopped rising and the violent updrafts associated with the explosion have subsided, the larger and heavier particles start falling back to the ground. The result is an area around ground zero and extending downwind which is covered in a more or less systematic way with radioactive particles.

In the case of an air burst in which the white-hot fireball never reaches the surface, the radioactive fission products never come into close contact with the surface material; they remain as an exceedingly fine aerosol. At first sight, this might be thought to be an oversimplification, since there have been many cases in which the fireball never touched the ground, but the surface material was ob-

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This article is, with minor changes, the text of the summary report of the Committee on Meteorological Aspects of the Effects of Atomic Radiation. It is one of six reports prepared for the Study of the Biological Effects of Atomic Radiation by the National Academy of Sciences. The members of the committee are Harry Wexler, U.S. Weather Bureau, *chairman*; Charles E. Anderson, Geophysics Research Directorate; R. R. Braham, Jr., Institute of Atospheric Physics; Merril Eisenbud, U.S. Atomic Energy Commission; D. Lee Harris, U.S. Weather Bureau; B. G. Holzman, Air Research and Development Command; H. G. Houghton, Massachusetts Institute of Technology; W. W. Kellogg, Rand Corporation; Heinz Lettau, Air Force Cambridge Research Center; N. M. Lulejian, Air Research and Development Command; R. J. List and Lester Machta, U.S. Weather Bureau; and William K. Widger, Geophysics Research Directorate. The following changes have been made in the text: some subheads have been omitted and others have been shortened; all units of measurement have been spelled out. The full texts of all six summary reports are available from the National Academy of Sciences. The texts of the technical reports will be published in monograph form by the NAS.

served to have been sucked up into the rising atomic cloud. Actually, however, in such cases a survey of the area has shown that there has been a negligible amount of radioactive fallout on the ground. Though tons of sand and dust may have been raised by the explosion, they apparently did not become contaminated by fission products.

Experience has shown that an atomic device exploded on the surface distributes about 70 to 80 percent of its fission products on the ground within a few hundred miles of the burst point. A somewhat larger percentage will take part in the close-in fallout from an underground burst, and a smaller percentage will be scavenged from a near-surface burst or tower shot.

In order to make a quantitative study of the manner in which close-in fallout occurs, one must have a knowledge of the following parameters: wind structure, yield and height burst, and kind of surface.

As each particle falls, it is carried horizontally by the wind at each level. The time during which it is falling through a given layer is inversely proportional to its rate of fall. Thus its horizontal travel during its entire fall from an initial height can be expressed as a summation of its horizontal travel in each layer. The rates of fall of atomic particles vary with particle size, shape, and density, as well as the altitude.

Although no experimental information is available on the effects of precipitation during the initial stage of the atomic cloud, it is evident that significant deposition can occur from this cause. However, the effect would be most marked from smaller yield bombs, since the bulk of the debris from larger bombs rises well beyond the rain-bearing strata.

Height and size of the atomic cloud at the time of stabilization. It is evident that the physical size of the atomic cloud will have an effect on the distribution of the close-in fallout. The height to which the debris is carried will determine how far downwind a given particle size will drift, and the horizontal extent will serve to spread the fallout over a larger area.

In the first few seconds following an atomic detonation, the fireball grows rapidly until the pressure inside the fireball is roughly that of the ambient air. At this point its temperature is still many thousands of degrees higher than that of the atmosphere around it, so it is much less dense, and the buoyancy of the atmosphere forces it to rise. However, it does not necessarily rise like a hot "bubble" or a balloon, but in most cases, it develops a strong toroidal internal circulation and rises in the form of a smoke ring.

As the smoke ring rises, its internal circulation draws air in at the bottom and incorporates this new air into the cloud. The result is a very large growth in the size of the cloud as it rises, due mostly to the entrainment of the air from each level through which it passes.

It is clear that the cloud will gradually cool during its rise, due to radiation, the entrainment of the outside air, and adiabatic expansion. When the mean temperature inside the cloud is the same as that of the ambient air at the same level, there will be no further buoyancy and the cloud as a whole will cease rising. However, at this point the kinetic energy of the toroidal circulation may still be considerable. For devices with yields of a few kilotons, the smoke ring circulation breaks up at about the same time that it reaches its point of stabilization, but for devices in the megaton range this toroidal circulation continues to pump air in at the bottom for 10 to 20 minutes.

The net result of this pumping action after stabilization is a significant increase in the horizontal size of the atomic cloud, since the air which is drawn in at the bottom is forced out radially. Observations of this effect in the case of megaton devices are hindered by the fact that the structure of the cloud becomes confused.

The atmospheric stability will vary with the season and latitude, and this accounts, in part, for the difference between the altitude of a cloud detonated in a tropical atmosphere and one of the same yield [detonated] in a middle-latitude winter atmosphere. The most noticeable difference between these two regimes is the height of the tropopause.

Distribution of radiactivity within the cloud. Since it is difficult to obtain enough samples of the radioactive debris while it is still within the cloud to determine its initial distribution, the most reliable estimates of this distribution have been based on the observed fallout and a reconstruction of what this initial distribution must have been.

It is clear from the observations of the rising cloud that almost all of the lighter debris is carried aloft in the smoke ring cloud. Apparently a certain fraction of particles are large enough to be thrown out of this ring, and these are left behind in the stem. However, in the stem there are violent updrafts for the first few minutes, so all but the very large particles will continue to be carried aloft.

For a surface or near-surface burst, the type of terrain must have a significant influence on the particle size and activity distribution within the cloud.

Prediction of close-in fallout. At the outset it would be well to state what use can be made of a prediction of the fallout area from an atomic burst. At the risk of oversimplifying the case, here are some of the pertinent factors.

1) Wind observations, now almost invariably made with sounding balloons, give winds which are not entirely representative of the winds which will affect the falling atomic debris. This is because winds change with time and place and because wind observations, as all meteorologists recognize, are subject to a certain amount of error. Forecast winds, by the same token, are usually even further in error. A number of studies have been made of this subject. For example, a recent study by the Air Weather Service indicates that mean vector errors in 24-hour forecasts range from about 60 percent of the observed wind at middle altitudes to over 70 percent of the observed wind at 100 millibars (about 53,000 feet). These mean vector errors correspond to wind errors of 18 to 29 knots. It is perhaps significant that the forecast errors at the higher levels (40,000 to 55,000 feet) are about the same as the root-mean-square deviation of the wind from the mean wind, and at lower levels (about 20,000 feet) the 24-hour forecast error is about half that of the normal climatological deviation. If one had to rely on forecasts 24-hours old, he would be just about as well off as if he used climatological data or persistence in computing the fallout.

2) The mushroom cloud from a multimegaton device may rise entirely above the normal coverage of our radiosonde and RAWIN network, since it is generally considered impractical to plot and analyze current weather data at levels above 100 millibars. . . . Thus, unless special efforts are made, there will simply be no wind data at all for the winds which will affect the debris during the first part of their fall. The effects of vertical motions in the atmosphere, possibly including currents arising from bomb-produced fires, may also be enough to alter the fallout pattern.

3) It should be fairly evident from the discussion in the preceding section that there are still a number of questions concerning close-in fallout about which we are still somewhat uncertain. Any fallout computation, even given perfect information on the wind field, will have a degree of uncertainty as a result of the assumptions on which it is based.

With these factors in mind, it appears unlikely that a weather forecaster, even given the computing aids which he would need to compute a fallout pattern, could on short notice and in a time of emergency give a detailed and reliable forecast of the close-in fallout. He could with a fair degree of assurance delineate the general sectors in which the fallout would be most likely to occur, but he could not tell where a given dose-rate contour would lie. If one is dealing with a military situation in which an enemy is dropping atomic bombs, then the forecaster's problem is further complicated

by the fact that he would presumably not have accurate knowledge of the height of burst and fission yield of the weapon.

It must be emphasized, however, that the above statements do not necessarily apply to the prediction of the fallout from a test device, where many of the uncertainties mentioned can be removed. It is possible, by the use of a special upper air-sounding network, to obtain wind information over a limited area which is considerably more reliable and current than that obtained from the routine upper air net, and which extends to a greater altitude. Moreover, there is usually no doubt about the yield and burst height of the device during a test. Thus, it is much more likely that an accurate forecast of the fallout pattern can be made under the favorable conditions which exist during a test. Even here, there remains a degree of uncertainty, as witnessed by the fallout which occurred on some inhabited atolls during the 1954 tests in the Pacific—though this might have been forecast if there had been the refined fallout computing aids which exist today.

Finally, if one does not have to make use of forecast winds at all, but can introduce all the detail of a careful synoptic analysis "after-the-fact," including the time variation of the wind at each level, and compute the fallout on a high-speed computer, it is possible to reproduce the fallout patterns which have occurred from the United States surface bursts with considerable accuracy. The radiological monitoring data show a certain amount of spread in the observations because of the detailed effects of terrain and atmospheric turbulence. When the reconstructed pattern or computed fallout patterns are compared with observed values, the minor differences are usually accounted for by small-scale features in the wind structure. Where the winds apparently behave as expected, predictions verify within a factor of 2 over most of the area. Where they do not, the peak dose rate is often correctly predicted at various distances from ground zero although displaced relative to the observed peaks.

Intermediate Fallout

Although gravitational settling continues to play an important role for many days and the downward diffusion of debris from the atomic cloud as it is moved about by the upper winds also becomes important, the primary removal of debris after the first day or two following a burst occurs in areas of precipitation. As the cloud of debris continues to be diluted by the atmosphere, concentrations decrease and it becomes necessary to collect the fallout and wait until the natural radioactivity has decayed before measurements can be made.

From Nevada test series, it has been found that less than 5 percent of the total beta radioactivity produced is collected by the gummed film network in the United States. Stewart, Crooks, and Fisher have estimated from observations in the British Isles that about half the radioactive dust in the troposphere from Nevada tests is deposited in approximately 22 days and that 80 percent of the deposition by rain occurs during the first transit of the cloud over England.

The importance of precipitation in bringing debris to the ground after the first day or so following an atomic explosion is strikingly shown in the average daily activity found on gummed films exposed in the United States during the Teapot Nevada test series in the spring of 1955. In light rain, on the average, over twice as much activity is collected by the gummed film as compared to dry days and this increase becomes more apparent as the rain gets heavier. Various studies have shown that anywhere from 4 to more than 10 times as much debris is deposited during periods of rain as compared with dry days.

On a few occasions, rain has coincided with the passage of a fresh cloud of debris from a Nevada test, resulting in local increases of background radiation to about 1 milliroentgen per hour beyond a few hundred miles from the test site.

In the absence of precipitation, the effects of turbulence as well as gravitational settling are important.

Removal of debris by impaction on natural surfaces, buildings, and so forth, resulting from the movement of air around these surfaces must be appreciable. Various studies have shown that radioactive particles are found on leaves, branches, and so forth. An experiment conducted at the Naval Research Laboratory with an 80-mesh stainless-steel wire screen and with ordinary cheesecloth faced into the wind showed that in the absence of rain as much as 10 to 100 times the activity collected on the horizontal gummed film can be collected on the screen or cloth. In a 2-month period during the Teapot series, a total of 50 percent more activity was collected on the cheesecloth than on horizontal gummed film of similar size. Studies of the vertical distribution of chloride particles also indicate a depletion near the ground over land areas, presumably a result of impaction on natural surfaces.

Delayed Fallout

In contrast to the results from the Nevada tests, measurements of radioactive debris concentrations in the troposphere showed a continued increase over England during the 10-month period following the thermonuclear tests in the Pacific in 1954. Similar increases in ground-level concentrations have also been observed by the Naval Research Laboratory in the United States and elsewhere.

This delayed fallout is a consequence of the extreme heights reached by debris from thermonuclear explosions—more than 80,000 feet—which results in the storage of large amounts of small particle-size debris in the stratosphere. The existence of such a distribution has been confirmed by aircraft measurements over the British Isles in August and September 1954 and again in early 1955 which show a very large increase in air concentration above about 35,000 feet. This debris eventually moves through the tropopause into the troposphere, from where it is removed by precipitation scavenging and by deposition.

Transport in the stratosphere. The stratospheric levels in question are mainly in a region where relatively sparse synoptic data on the structure or air currents are available. However, they are mainly in a region of hydrostatically stable air, and soundings indicate, in general, a relative high degree of steadiness of stratospheric currents.

The winds in the stratosphere seem to have a predominant zonal component. The material injected at a certain locality will spread to other longitudes faster than to other latitudes. Material injected at a certain time in a vertical column may move more rapidly, or even in a different direction, at one level with respect to another. This shearing motion of the large-scale air currents represents a powerful factor for the spreading of an originally localized cloud to all longitudes within a few weeks.

All stratospheric circulation cells undergo more or less marked changes during the course of the seasons. Superimposed on the seasonal trend are day-to-day wind fluctuations caused by migrating or oscillating pressure systems. The present-day knowledge of independent stratospheric pressure systems is very limited. But it can be assumed that the stratosphere reacts, at least partly, to the migrating cyclones and anticyclones of the troposphere. Over periods of several weeks the net effect of the stratospheric wind variability will be similar to a process of large-scale eddy diffusion acting mainly in the horizontal directions.

Diffusion in the stratosphere. One may approach the question of vertical diffusion in the stratosphere in three ways: (i) by using first principles; (ii) by using natural gaseous tracers; and (iii) by using man-made probes.

1) First principles. If asked for criteria to predict vertical mixing at the ground from meterologically observed

parameters, one would point, in all likelihood, to three items: vertical temperature gradients, wind speed, and wind shear. The greater the temperature stability, the less the vertical mixing. It is primarily on this ground that the stratosphere has been viewed as a region of quiescence in comparison with a turbulent troposphere below it.

With regard to wind speed, it seems fairly clear that an absence of horizontal kinetic energy will be associated with little or no vertical motions, but it is not evident that high wind speed necessarily will produce vertical turbulence. In any event, the lower stratosphere has a variety of speeds.

In the Richardson number, which under special conditions predicts the onset of turbulence, it is the shear rather than the wind speed which is significant. There is as large an assortment of wind shears in the stratosphere as in the troposphere, barring the layer adjacent to the jet streams in the troposphere.

One must conclude that on one count —probably the most important—stratospheric vertical mixing should be much smaller than tropospheric and that on the other two scores, it need not be.

2) Gaseous tracers. Ozone is the first such atmospheric property which comes to mind. It has been established that the ozone concentrations below the ozone maximum (about 25 kilometers) are often in excess of the photochemical equilibrium amounts. It appears that the day-to-day variation and much of the seasonal variation of total ozone reflects changes in the nonequilibrium ozone in the "protected" region below the maximum. It is generally accepted that exchange processes transport ozone downward from the region of ozone maximum. Three types of exchange process have been considered. The first involves large-scale meridional circulations in the stratosphere. There are some reasons for accepting such a meridional circulation involving both hemispheres, but the evidence is not very impressive. A second exchange process is turbulent mixing. This is difficult to evaluate because of the lack of information on the magnitude of the mixing coefficient. It does seem, however, that the mixing coefficient required to provide the needed flux of ozone is not unreasonable. The third exchange process may be called *Gross austausch* since it involves the vertical motions associated with traveling cyclones and anticyclones. There is good evidence for this effect in the correlations between total ozone and the pressure field. It also provides a qualitative explanation for the annual variation of total ozone.

With the possible exception of the large-scale meridional circulation, the exchange processes described here will operate to bring ozone into the troposphere where it is destroyed at lower levels by particulate matter. The study and measurement of the ozone exchange should be applicable to the exchange of nuclear weapon debris.

Water vapor probably has no marked sink (due to cloud formations or precipitation) near the tropopause. Thus, changes in the gradient of water vapor mixing ratio should be a clue to the comparative upper tropospheric-lower stratospheric mixing intensities. The use of moisture as a tracer suggests but does not clearly indicate little vertical mixing in the lower stratosphere.

3) Man-made probes. Both parachutes and balloons have been used regularly to measure small-scale vertical motions in the stratosphere, and the results generally reveal the stratosphere to have greater vertical motions than the troposphere. Also, aircraft report turbulence in the stratosphere. This evidence for comparatively short-period vertical motions is clouded by the question of the role of the platform. The growth of the rising balloon, for example, alters the flow around it which may be the cause for the apparent vertical motions deduced from its ascent rate. Further, as with any measure of vertical motions, the probe does not distinguish between nondispersive vertical motions like gravity waves and true diffusing elements.

Mixing through the tropopause. In a practical definition the tropopause is the level of minimum temperature of a high-altitude sounding, or the layer of maximum change of vertical lapse rate of temperature when no minimum temperature is encountered. Mean height-latitude cross sections of the atmosphere show that the tropopause is quasi-horizontal only in equatorial and polar regions, at approximately 18 and 9 kilometers, respectively. The break occurs normally between 30 and 60 degrees latitude, where the mean tropopause has either a significant slope or lacks uniqueness of definition so that multiple tropopauses are assumed by some authors even for mean conditions. Individual soundings may show considerable day-to-day fluctuations of the tropopause level in connection with the passage of cyclones and anticyclones. Therefore, the tropopause is far from being a well-defined geometric surface and can hardly be considered an internal boundary which separates two distinct kinds of air masses. Air may move vertically through the mean tropopause level, or horizontally through the tropopause breaks. However, net radiation and convection processes are assumed to exist which result in a marked tendency toward reestablishment of the tropopause at preferred levels just above the atmospheric layer in which the content of liquid and vaporous water is significant and condensation-precipitation cycles are dominant.

Four main types of exchange of air, or air properties through the tropopause may be distinguished: (i) small-scale vertical exchange, or vertical eddy diffusion; (ii) medium-scale penetration of tropospheric air into the stratosphere above extremely intense convective cells (heavy squall lines, frequently connected with tornadoes); (iii) large-scale entrainment of stratospheric air into tropospheric systems, such as cyclones, jet streams, hurricanes; and (iv) mean transport by vertical branches of large-scale to world-wide circulation cells.

Tropospheric removal. The very small particles which are originally in the stratosphere and reach the troposphere weeks, months and even years after the detonation of a thermonuclear weapon must eventually be deposited in the biosphere. However, the mechanisms by which these small particles are finally removed from the troposphere are not clear, and the data concerning this problem are inconclusive.

Investigations of the rate of removal of natural radioactivity from the lower troposphere, both in the United States and in Germany, indicate that about half the activity is removed in a period of about 1 or 2 weeks. However, the particles involved are extremely small (probably less than 0.01 micron) and are concentrated near the ground, so that the results may not be applicable to the fallout problem. On the other hand, Langmuir has shown that the collection efficiency of precipitation for very small droplets (less than 1 micron) is small, but again the results may not be applicable to the fallout problem, where electrostatic and surface tension phenomena are different. Agglomeration between natural cloud elements and radioactive particles is operative for small particles.

Conflicting evidence on the rapidity of tropospheric removal is also found in studies of the actual fallout. Stewart, Crooks and Fisher, in Britain, estimate from indirect reasoning that deposition in rain exceeds dry deposition by a factor of 20 for thermonuclear explosions. A study of gummed film results in the United States does not bear this out—average monthly deposition at 40 monitoring stations during September and October 1954 shows no correlation with either total rainfall during the month or the number of days with rain at the station. Again, using the British data, it is seen that the specific activity of the lower atmosphere showed a more than fourfold increase during the interval from 10 weeks after the Pacific tests to 50 weeks after if the data are corrected for decay. Similar increases were

found by the Naval Research Laboratory. It is hard to reconcile this increase in tropospheric concentration with the rapid cleansing of the troposphere.

Analysis of Stratospheric Storage from Radiostrontium Fallout Data

The fission product of greatest interest in terms of long-term hazard from nuclear detonations appears to be strontium-90, and estimates of the rate of deposition of this isotope in the biosphere are needed. Unfortunately, our knowledge of the physical mechanisms involved is too meager to deal with this problem on a theoretical basis. Although it has been established that a considerable amount of debris is injected into the stratosphere and that this debris slowly mixes downward into the troposphere and is eventually deposited on the ground, the average storage times in the stratosphere, and even in the troposphere, are uncertain. Among the many unknowns in attempting a theoretical analysis are the initial distribution in the stratosphere and the physical mechanism of stratospheric removal. Even if the latter were known, we are at present unable to make quantitative estimates of the rates or intensities of these physical processes. However, due to the biological uncertainties in estimating the hazard from strontium-90, a precise answer is not needed, and even a gross estimate would be useful.

W. F. Libby of the U.S. Atomic Energy Commission has published an estimate of the stratospheric storage time based on the estimated stratospheric content and on the observed deposition, with little or no reference necessary to the physical mechanisms involved. Essentially, the annual deposition is divided by the amount in the stratosphere, yielding the fractional removal during the year. If the fractional removal rate is assumed constant (that is, the stratospheric content is assumed to decrease exponentially) the mean residence time of the debris is given by the ratio of the stratospheric content to the deposition.

The basic data used by Libby are the stratospheric content immediately after the completion of the Castle tests (spring 1954) in the Pacific and the deposition of strontium-90 during the following year or so as measured in three ways: a worldwide gummed film fallout network, the strontium-90 content of Chicago rainfall, and air-filter measurements at Washington, D.C. From these results, Libby concludes that the mean storage time for debris in the stratosphere is approximately 10 ± 5 years.

Stratospheric storage not only serves to delay the fallout of debris but also to disperse it over the globe, minimizing the chance of locally high concentrations of debris. At present, the amount of strontium-90 in the stratosphere from nuclear weapon tests is far too small to approach maximum permissible concentration even if it were to be all deposited now. However, if the testing programs of the several countries producing thermonuclear weapons were to be intensified, stratospheric storage time may become a critical item in terms of hazard to mankind. For this reason, a continuing program to investigate this phenomenon is needed, including actual measurements of the radioactivity in the stratosphere and improved and more representative methods of observing fallout.

Atmospheric Radioactivity from Civilian Use of Nuclear Energy

The hazards of atmospheric contamination from the military uses of atomic energy have tended to overshadow other possible sources of contamination, principally because, to date, relatively insignificant contamination has occurred from nonmilitary sources. Certainly the near future will see a tremendous increase in the utilization of nuclear energy for peaceful purposes, including the production of electric power; medical, industrial, and agricultural applications; and nuclear propulsion of air, sea, and land vehicles.

As far as can be seen today, the largest potential use of nuclear energy will be in the production of electric power, and this discussion is based on this aspect of the problem; however, other applications could conceivably double the values used in the estimates given here. A consensus of estimates of global power requirements and of the proportion of this energy which will be supplied by nuclear sources indicates that by 1975 there will be a nuclear heat energy production of 10^8 to 10^9 kilowatts and by the year 2000 this will increase to 10^9 to 10^{10} kilowatts.

These rates of production will produce enormous amounts of fission products. However, most of these will be in solid or liquid form at present-day processing temperatures, and it can be expected that such material will not be intentionally released into the atmosphere. Of the remaining volatile fission products, storage and "cooling" of the fuel before processing can reduce the activity materially. The two volatile isotopes of most interest are 10-year krypton-85 and 8-day iodine-131. Only the 10-year krypton is sufficiently long-lived to be relatively insensitive to the cooling time of the fuel before processing. There are two aspects to the problem of radioactive hazard from these sources, large-scale contamination on a global or hemispheric basis and local or regional contamination in the areas of processing plants.

Large-scale contamination. The long half-life of krypton-85 results in the accumulation of this isotope in the atmosphere. If by the year 2000 nuclear thermal power has risen to 10^{10} kilowatts, the world inventory of radiokrypton would be of the order of 10^{10} curies. Mixed uniformly through the mass of the troposphere (4×10^{21} grams of air), the resulting sea-level concentrations would be less than 10^{-8} curies, per cubic meter. Since most of the activity is likely to be released in the middle latitudes of the northern hemisphere, large-scale concentrations of 3 to 5 times the global average could be experienced in these latitudes.

No value for the maximum permissible concentration of krypton-85 is presently available. If, from the chemical and radiological similarity, we assume that it is analogous to radioxenon, then the estimated world-wide concentration in the year 2000 is about two orders of magnitude less than the maximum permissible concentration. However, such comparisons are extremely questionable and it is important that maximum permissible concentration levels be established for krypton-85.

The problem of iodine-131 in the atmosphere is largely dependent on the fuel recharging interval and the cooling time. For each combination of fuel cycle and cooling time, it is possible to calculate the total amount of iodine-131 in the atmosphere. This is an equilibrium value assuming no removal at the source or after release. Total amounts of iodine-131 in the atmosphere based on the estimated nuclear energy production in the year 2000 are given in the Table [1].

The present maximum permissible concentration of iodine-131 is 3×10^{-9} curies per cubic meter. If the iodine-131 is mixed with the whole mass of the troposphere, then 10^{10} curies would produce the maximum permissible concentration. However, the assumption of world-wide tropospheric mixing is unwarranted for an isotope with a half-life of 8 days. Assuming the term large-scale contamina-

Table 1. Total iodine-131 (curies) in the atmosphere per 10^{10} kilowatts of nuclear energy.

Fuel recharging frequency	Decay time before release		
	None	10 days	100 days
Once a year	6×10^9	3×10^9	10^8
Ten times a year	6×10^{10}	3×10^{10}	10^7
Continuous	2×10^{11}	10^{11}	4×10^7

tion in the case of iodine-131 can at most involve a 20°- or 30°-band of latitude in the northern hemisphere, and that vertical mixing may be incomplete, then even for large-scale considerations, an atmospheric burden of 10^8 or 10^9 curies of iodine-131 may approach the maximum permissible concentration, and appropriate cooling or decontamination measures must be used.

Local contamination. It is evident that consideration of the average contamination over major portions of the globe cannot approach the hazard to be found in local areas downwind from sources of contamination. Locally, higher concentrations that would exist 10 to 100 miles from fuel processing plants (assuming something of the order of 1 percent of the world's fuel to be processed at any single site) could add an additional factor of 10 to 100 in the case of krypton-85 and several thousand in the case of iodine-131. Also, transitory excess concentrations due to unfavorable meteorological conditions could raise local concentration by an additional one to two orders of magnitude.

These effects are cumulative so that concentrations of iodine-131 about 10^4 times the global average could occur regularly near fuel processing plants in the northern temperate latitudes, rising occasionally to 10^5 or 10^6 times the global average during unfavorable meteorological conditions. Deposition by precipitation could increase the possibilities of harmful effects. Further detailed analysis would be required in order to indicate under what conditions the concentrations of krypton, iodine, or other isotopes would exceed permissible limits. In any case, it seems that a combination of reasonably conservative fuel cooling periods, some progress in off-gas cleaning, and a judicious choice of fuel processing locations is indicated to minimize the adverse effects of unfavorable meteorological conditions. At the larger plants, meteorological scheduling of gas releases may be required. These principles are applied today and will become increasingly important.

Accidental releases. There is the possibility, even if remote, that a large high-power reactor or fuel processing facility could be damaged or destroyed by accident and release part or all of the contained fission products to the atmosphere. The results of such an event could well be catastrophic and extend over great distances. Estimates of areas of damage range upwards of thousands of square miles for very large reactors. By the year 2000 the release of only about 1 percent of the world-wide strontium-90 inventory that could then exist, even if mixed uniformly throughout the global troposphere, could produce concentrations on the order of 5×10^{-10} curies per cubic meter or about twice the currently recommended maximum permissible concentration. This same 1 percent, if deposited on the surface, could seriously contaminate the entire area of the earth. It is more likely, in the event of such a catastrophe, that the activity would remain concentrated in a much smaller area near the source. Still, the operation of any significant fraction of the earth's nuclear reactors without proper safeguards would be of concern to all.

Conclusions. Solution to the radioactive air pollution problem is the same as in other air pollution problems—prevention of the escape of pollutants to the atmosphere. Thus, primary consideration must be given to engineering features limiting the escape of hazardous gases either during normal operations or accidents. As an additional safety factor, meteorological research to locate plants in areas where unexpected releases will do the least damage is desirable. Finally, it should be pointed out that the release of a hazardous substance by any country may affect other countries, particularly in the same latitude belt. International control to establish and maintain high standards of safe plant operation is essential.

Use of Radioactivity in Atmospheric Studies

Natural radioactivity. There exist two important sources of naturally occurring radioactivity in the atmosphere: (i) cosmic ray interactions in the stratosphere and (ii) the rock and soil of the earth's outer crust. The study of the cosmic-ray-induced products entails considerable difficulties because of the low level of activity. On the other hand, the radioactive substances which originate in the earth can be detected and measured with relative ease.

Radon and thoron are released as gases in the radioactive decay of radium and thorium, which are found in all rock and soil. The concentration of these gases and their distribution in the atmosphere are determined by their half-lives and by meteorological conditions. Although it is considered generally that the relative amounts of the various natural activities are dependent on meteorology, very few correlations with specific meteorological parameters have been made, in spite of the fact that measurements have been carried out over a period of many years. At the present time, insufficient data are available to make reliable estimates of the global distribution of radioactivity in the air over land, although it is known that at some distance from large land masses the radioactivity concentration is exceedingly low. Measurements indicate that the amount of radon decreases rapidly with altitude to about one half the surface value at 1 kilometer.

Radon and thoron and their daughter products would seem to provide an easily detectable tracer for the study of the vertical *Austausch.* Ground-level measurements indicate that exchange phenomena within even a few feet of the surface have marked effects on the concentration of radioactivity. Such measurements might well be carried on in conjunction with micrometeorological observations. From consideration of the lifetimes of the radioactive isotopes which are involved, it is obvious that even for relatively low wind velocities, horizontal transport of these radioactivities over distances of several hundred miles is entirely possible. The study of simultaneous variations in concentration over these distances should be valuable if the locations were carefully selected to avoid the effects of terrain. Land to sea measurements should be especially interesting.

Instances of increases in radon concentration coincident with air pollution have been reported. Since atmospheric radioactivity and pollution are strongly affected by the stability of the lower atmosphere, this effect is not surprising. For the same reason, it is quite possible that a relationship could be established with the tropospheric scattering of electromagnetic radiation.

Experiments have shown that the radon and thoron decay products are attached to submicron particulates. The details of the attachment process are not well understood—for example, the relationship between various ionic species or the number and kind of nuclei. These radioactivities exist in the form of a readily detectable submicron aerosol which generally follows the surface wind pattern. These small particles, and incidentally other pollution, appear to be removed from the lower atmosphere in a matter of days, principally through precipitation. Further study of this removal process, carried out at different locations and for a variety of climatological conditions, would perhaps shed some light on the scavenging efficiency of precipitation.

The natural radioactivity of precipitation is considerable and is easily measurable. The mechanism for the entrainment of the radioactive particles in rain droplets is not certain. From theoretical considerations, the probability for attachment of these very small particles in rain is quite low. It has been suggested that the radioactive ions could themselves act as condensation nuclei. On the other hand, there is the possibility that clouds of charged radioactive particles could act as a sort of "trigger" for electric phenomena leading to cloud electrification and precipitation. Experimentally, the difficulties of working with large volumes

of rainwater are partially offset by the large activities encountered. The actual air volume swept out by precipitation is very great and it would seem that there are possibilities for tracing air masses by using natural radioactivity.

Traditionally, atmospheric radioactivity has been associated with atmospheric electricity and might well supplement studies in this field. The radon and thoron decay products are charged and can be collected by electric means. They are estimated to cause about one-half of the ionization in the lower atmosphere. Certain of the theories of atmospheric and cloud electrification are quite sensitive to changes in the ion concentration. Since large changes in the radioactivity concentration are the rule, further studies carried out in conjunction with atmospheric electric measurements should be valuable.

The most extensively studied of the cosmic-ray-induced isotopes found in the atmosphere have been carbon-14, tritium, and beryllium-7. Probably both short-term increases in fossil carbon dioxide from industrial sources and the long-term global distribution could be detected using sensitive techniques. Tritium is present in the air principally in the form of tritiated water and will probably find its most useful applications to hydrology, although more extensive sampling of precipitation is no doubt desirable. Because of its relatively short half-life, beryllium-7 may be of very great importance in the study of the rate of mixing between the stratosphere and troposphere. Unfortunately, there is a great lack of experimental information suitable for correlation with meteorological phenomena.

Debris from weapons tests. The debris injected into the atmosphere from the testing of nuclear weapons can provide a useful tool for investigating atmospheric phenomena. However, two basic limitations on the usefulness of the approach must be recognized. (i) The source strength and distribution in space is largely unknown. Such important information as the distribution of particles with altitude, the exact configuration of the stabilized cloud, the relation of particle size to activity, the fractionation of elements within the cloud, and so forth, is not available. (ii) Sampling techniques are imperfect. Air-concentration measurements are difficult because of the low concentrations and small particle sizes involved. Ground collections result from either deposition of the particles themselves or by precipitation scavenging.

Using the gummed-paper collection system described in [the first section of this report], it has been possible to obtain certain valuable meteorological information on such items as a measure of the cross-equatorial transport and some feature of the general circulation from U.S. Pacific tests, scavenging by the upper portions of rain clouds of the particulate fission products, an estimate of rapidity of the removal of particulates from the troposphere, and an estimate of the rate of transport from the stratosphere to troposphere.

Using aircraft sampling procedure, it has been possible to obtain estimates of the rate of lateral spread of an atmospheric contaminant and verifications of meteorological trajectories. By following the tritium released by the Castle series of weapons tests, it has been possible to estimate the removal time for atmospheric water molecules.

It is likely that the potential of even the existing unclassified information on radioactivity released by weapons tests has not been exhausted. This potential would be enhanced by disclosure of additional information on weapons, debris measurements, and source strengths. For example, the weapons tests offer an opportunity to determine storage and transit time parameters for surface water sheds of almost any size. By comparing the amount and level of radioactivity in rainfall and runoffs as a function of time following a weapons test, it would be possible to measure those parameters which are vital to studies of ground water, river runoff, and flood forecasting.

Artificially introduced radioactive tracers. Artificially introduced radioactive tracers can serve meteorology in at least three fields: (i) through the delineation of the air flow and rates of diffusion; (ii) in hydrometeorology, including studies of condensation, precipitation, evaporation, and hydrology; and (iii) in atmospheric electricity.

As a tracer of air motions, radioactive substances are in competition with fluorescent dye particles, sulfur dioxide, and other nonradioactive substances. Their advantages lie in the possibility of being able to treat large-scale atmospheric phenomena which otherwise require too large amounts of source material, in being able to utilize tracers which partake in the particular process under investigation and, in certain cases, in our ability to detect the presence of the tracer instantaneously in the field. In any specific experiment, it will be necessary to weigh economic, safety, and scientific factors in the use of radioactive tracers over nonradioactive tracers.

Regions in which it would be highly desirable to further knowledge concerning air trajectories are in the neighborhood of jet streams, in cols, in hurricanes to measure both the three-dimensional airflow and to define the air comprising the eye, and in the antarctic. In the field of diffusion, the use of radioactive tracer material can further knowledge of diffusion near the ground for air pollution studies, and so forth, and of diffusion in the stratosphere and tropospheric and stratospheric mixing.

The radioactive tracer material which appears to be most promising for the above meteorological studies is tritium. Tritiated water would be washed out, thus making for additional complications. Tritium in the form of ordinary hydrogen is acceptable although costs of analysis of the sample might be high. For the large-scale experiment to establish the tropospheric-stratospheric exchange, tritiated methane has been suggested. Tritium has the advantageous properties of emitting a weak beta particle, of being available without difficulty, and of having a reasonably long half-life.

Water molecules are readily marked by tritium so that in any experiment in which the travel of water vapor is desired it becomes feasible to introduce tritiated water as a tracer. If sufficient amounts of tritium were available, a large-scale experiment to study the hydrologic cycle could be devised. Even on smaller scales, tritiated water could be used to study such features as the evaporation from a ponded lake, water sources for dew, contributions of local transportation or evaporation from local bodies of water to precipitation elements, and so forth.

Activation analysis techniques extend the possibilities for studying very small particles (such as sodium chloride) that play an important role in condensation and ice formation. Radiosilver can be introduced in a preparation of silver iodide to determine the presence of silver iodide in the precipitation which was alleged to be stimulated by it. By releasing another tracer which would be scavenged with equal efficiency by precipitation, it might be possible to determine whether the silver iodide has played a role in the formation of the precipitation.

Finally, the ionizing properties of radioactive substances can be used to make local changes in the electric fields of the atmosphere to determine whether or not such changes affect weather processes.

Atomic Explosions and Weather

From the beginning of time, man has looked beyond the field of meteorology in the hope of finding some explanation for the vagaries of weather. Many inventions of man—gunpowder, radio, airplanes, and television—have been blamed for changes in weather and climate. It is only natural that atomic and thermonuclear explosions, being among the most dramatic achievements of mankind, would come in for their share of the blame.

There seems to have been an increase in unusual and undesirable weather in the past decade. When submitted to rigorous statistical tests, these apparent abnormalities do not exceed the limits that can be expected by chance and are consistent with accepted meteorological principles involving large-scale (hemispheric) weather patterns which could not be directly affected by the explosions. The failure to detect statistically significant changes in the weather during the first 10 years of the atomic age is no proof that physically significant changes have not been produced by the explosions, but it does show that a careful physical analysis of the effects of atomic and thermonuclear explosions on the atmosphere must be made.

The energy of even a thermonuclear explosion is small when compared with most large-scale weather processes. Moreover, it is known that much of this energy is expended in ways that cannot directly affect the atmosphere. Even the fraction of the energy which is directly added to the atmosphere is added in a rather inefficient manner from the standpoint of affecting the weather. Meteorologists and others acquainted with the problem are readily willing to dismiss the possibility that the energy released by the explosions can have any important direct effect on the weather processes. However, there remains the possibility that the explosion will serve as a trigger mechanism to divert some much larger natural store of energy from the path it would otherwise have followed.

Three general means by which this might be accomplished have been considered. (i) The debris thrown into the air by the explosion may have some catalytic effect on the behavior of clouds and thereby change the regime of cloudiness or precipitation over wide areas. (ii) The radioactive nature of the debris will change the electric conductivity of the air, and this may have some effect on more directly observable meteorological phenomena. (iii) The debris thrown into the stratosphere by the explosion may interfere with the passage of solar radiation and thereby serve to decrease the temperature of the earth.

Our present knowledge of atmospheric physics makes difficult a final authoritative evaluation of any of these possibilities. The results of studies and experiments conducted by various organizations show the following:

1) The debris which has been thrown up into the atmosphere by past detonations was found to be ineffective as a cloud-seeding agent. Since the techniques for testing nucleating efficiency are not entirely satisfactory, the condensation and freezing nuclei produced by nuclear explosions and their effect on the formation of clouds and the precipitation process must be continually investigated.

2) The amount of ionization produced by the radioactive material is insignificant in affecting general atmospheric conditions. Various theories on the possible connection between the electric properties of the atmosphere and the precipitation process are still in the developmental stage.

3) Dust thrown into the air by past volcano eruptions decreased the direct solar radiation received at the ground by as much as 10 to 20 percent. The contamination of the atmosphere by past nuclear tests has not produced any measurable decrease in the amount of direct sunlight received at the earth's surface. There is a possibility that a series of explosions designed for the maximum efficiency in throwing debris into the upper atmosphere might significantly affect the radiation received at the ground.

4) Much of the increase in severe storms reported in recent years can be traced directly to the improved methods of reporting severe storms that normally occur.

No statistically significant changes in the weather during the first 10 years of the atomic age have been found, yet careful physical analysis of the effects of nuclear explosions on the atmosphere must be made if we are to obtain a definite evaluation of this problem. Although it is not possible to prove that nuclear explosions have or have not influenced the weather, it is believed that such an effect is unlikely.

News of Science

British Report on Radiation Hazards

The Medical Research Council of Great Britain recently published a report of a special committee under the title *The Hazards to Man of Nuclear and Allied Radiations* (see editorial in this issue of *Science*). The conclusions of the report were as follows:

On the basis of the considerations in this report we feel justified in drawing the following conclusions in relation to the use of ionizing radiations in peacetime:

1) *Limitation of the use of all sources of radiation.* Adequate justification should be required for the employment of any source of ionizing radiation on however small a scale.

2. *Dose levels to the individual.* (i) In conditions involving persistent exposure to ionizing radiations, the present standard, recommended by the International Commission on Radiological Protection, that the dose received shall not exceed 0.3 r weekly, averaged over any period of 13 consecutive weeks, should, for the present, continue to be accepted. (ii) During his whole lifetime, an individual should not be allowed to accumulate more than 200 r of *"whole-body"* radiation, in addition to that received from the natural background, and this allowance should be spread over tens of years; but every endeavor should be made to keep the level of exposure as low as possible. (iii) An individual should not be allowed to accumulate more than 50 r of radiation *to the gonads,* in addition to that received from the natural background, from conception to the age of 30 years; and this allowance should not apply to more than one-fiftieth of the total population of this country.

3) *Dose level to the population.* Those responsible for authorizing the development and use of sources of ionizing radiation should be advised that the upper limit, which future knowledge may set to the total dose of extra radiation which may be received by the population as a whole, is not likely to be more than twice the dose which is already received from the natural background; the recommended figure may indeed be appreciably lower than this.

4) *Fallout from test explosions of nuclear weapons.* (i) The present and foreseeable hazards from *external* radiation due to fallout from the test explosions of nuclear weapons, fired at the present rate and in the present proportion of the different kinds, are negligible.

(ii) Account must be taken, however, of the *internal* radiation from the radioactive strontium which is beginning to accumulate in bone. At its present level, no detectable increase in the incidence of ill effects is to be expected. Nevertheless, recognizing all the inadequacy of our present knowlege, we cannot ignore the possibility that, if the rate of firing increases and particularly if greater numbers of thermonuclear weapons are used, we could within the lifetime of some now living, be approaching levels at which ill effects might be produced in a small number of the population.

5) *Recommendations regarding specific uses of radiation.* (i) All sources of radiation, both medical and industrial, should be under close inspection, in order to insure that the high standards of protection now attainable against the absorption of ionizing radiations, and against radioactive materials, are generally observed. Those using radiations should be instructed in the precautions to be taken, and no unnecessary or unauthorized person should be allowed to engage in such occupations. A personal record, not only of doses of radiation received during occupation but also of exposures from all other sources, such as medical diagnostic radiology, should be kept for all persons whose occupation exposes them to additional sources of radiation. (ii) Present practice in medical diagnostic radiology should be reviewed, with the object of clarifying the indications for the different special types of examination now being carried out and defining more closely, both in relation to the patient and to the operators, the conditions which should be observed in their performance. (iii) The uses of radiotherapy in nonmalignant conditions should be critically examined. (iv) The small amounts of irradiation from miscellaneous sources, such as x-ray machines used for shoe-fitting, luminous watches and clocks, and television apparatus, should be reduced as far as possible.

6) *Collection of vital statistics.* As an essential basis for future studies of the genetic effects of radiation, further data are required on the genetic structure of human populations; to this end, there is an urgent need for the collection of more detailed information, when births, marriages, and deaths are registered.

Anticlotting Drug

A new drug, polybrene, to counteract the anticlotting effect of heparin is reported by three Northwestern surgeons, Frederick W. Preston, Robert Hohf, and Otto Trippel, in the current issue of the *Quarterly Bulletin* of Northwestern University Medical School. The new drug was found to be "a suitable antiheparin drug for clinical use."

In a study of 33 patients, it was found that "polybrene promptly neutralized the anticoagulant effect of heparin." Heparin, which normally occurs in the body, prevents blood from clotting. When the heparin mechanism is disturbed, abnormal bleeding occurs, as in hemorrhage after birth, in leukemia, and in bleeding under the skin that causes bruiselike purple patches. In such cases antiheparin agents such as polybrene are useful in neutralizing heparin and, thus, permitting the blood to clot and the bleeding to stop.

Polybrene is similar to two other antiheparin drugs, protamine sulfate and toluidine blue, but "polybrene is more potent than either. It is stable and may be stored for long periods of time." Polybrene "must be given intravenously, slowly, and in dilute solution to prevent toxic effects."

Reactors for Denmark and the Netherlands

The U.S. Atomic Energy Commission has announced that the United States Government will contribute $350,000 toward the cost of a nuclear research reactor project to be undertaken by the Netherlands Centre and a similar amount for a similar project to be conducted by the Danish Atomic Energy Commission.

The American Car and Foundry Industries, Inc., of New York has been selected by the Netherlands to design, engineer, and construct the reactor. The buildings will be designed and constructed by a Netherlands firm. The project will be administered by the Netherlands Reactor Centre, a foundation established within the Netherlands Government in July 1955.

Cost of the reactor is estimated at $2 million or more, and cost of the entire project may run to $3 million. The schedule calls for completion of construction in 21 months following establishment of general specifications for the reactor and its associated equipment and buildings.

The reactor is to be a modified pool type similar to the new Oak Ridge (Tenn.) research reactor now under construction. It will be cooled and moderated with ordinary water and fueled with uranium containing approximately 5.7 kilograms of uranium-235.

The reactor will be used for research in agriculture, medicine, physics, and chemistry and to train people in the design and operational technology of both research and power reactors. Supporting facilities planned by the Netherlands include research laboratories and "hot" caves for handling radioactive material.

The Foster-Wheeler Corporation of New York will design and construct the mechanical components of the Danish reactor. Assembly and installation will be done by Danish firms in cooperation with Foster-Wheeler.

The Danes are planning a nuclear research center on a peninsula near Roskilde, some 20 miles west of Copenhagen. All laboratories and other facilities will be designed and built by Danish companies. The entire project will be operated by the Danish Atomic Energy Commission.

The reactor will be fueled with uranium containing approximately 5.7 kilograms of uranium-235 to be made available to Denmark by the United States. It will be cooled and moderated with ordinary water and will be similar to the Livermore (Calif.) pool-type reactor being constructed for the U.S. Atomic Energy Commission by the Foster-Wheeler firm. Initial cost of the reactor and its associated facilities is estimated to be approximately $1.4 million.

Two members of the Danish scientific staff to be assigned to the center are currently studying at the International School of Nuclear Science and Engineering near Chicago, Ill., which is operated for the U.S. Atomic Energy Commission by Argonne National Laboratory. Another staff member has had 6 months' experience in reactor technology at Brookhaven National Laboratory.

The Danish Atomic Energy Commission has plans to use the reactor for research and training in reactor physics, solid-state physics, metallurgy, reactor technology, radiochemistry, and production of radioisotopes for use in medicine, industry, and agriculture.

Priorities for Polio Vaccine

The U.S. Public Health Service recently recommended that state health agencies extend priority age groups for poliomyelitis vaccine to include all people under 20 and pregnant women as soon as the supply of vaccine warrants such action.

This announcement reiterates a recommendation made by the National Advisory Committee on Poliomyelitis Vaccine last April. The committee at that time recommended that states concentrate their polio program on children under 15 and pregnant women until maximum coverage of this group had been achieved. The Public Health Service, in accepting the committee's recommendation, said that the states should immediately broaden their priority group when this goal was reached.

In announcing the recommendation, Leonard A. Scheele, surgeon general, said: "To date, more than 72 million

cubic centimeters of vaccine has been released. There are about 53 million persons in the priority group of children under 15 and pregnant women; about 65 million persons would be included as the age limit is extended to 20. In some areas vaccine supplies are beginning to equal, or surpass, the immediate demand. In states where the demand for vaccine for the 0–15 age group continues to be high, it is important to satisfy that demand before broadening the priority group; however, in states where there is a lag in demand in the 0–15 group, every effort should be made to obtain maximum use of the vaccine before the peak of the polio season by extending priorities."

Expanding Universe

Substantial new evidence that the universe is expanding at the same rate in all directions has been obtained in a recently completed 20-year cooperative study by astronomers at the Mount Wilson-Palomar Observatories and the University of California's Lick Observatory. The conclusions are derived from the redshifts of more than 800 extra-galactic nebulae, or galaxies, in the universe beyond the Milky Way.

When interpreted as velocities of recession, redshifts provide the observational material for relativity theories of the expanding universe. Heretofore, uniform expansion of the universe has been inferred from relatively few observations of redshifts, for adequate experimental data have not been available prior to the completion of the present study, which consequently is of fundamental importance in astronomy.

A report has been published in the *Astronomical Journal* by M. L. Humason and A. R. Sandage of the Mount Wilson-Palomar Observatories, and N. U. Mayall of Lick Observatory. The program to determine redshifts was formulated in 1935 by the late Edwin Hubble.

New Atom Smasher

A new type of particle accelerator for study in continuous detail of the nuclear energy levels of heavy elements will be installed at Chalk River early in 1958, Atomic Energy of Canada Limited announced recently. To be known as the Tandem Accelerator, the 10-million-volt machine will consist of two Van de Graaff generators placed end to end in a horizontal position, giving the accelerator an over-all length of 34 feet and a diameter of 8 feet.

The beam of high-speed particles will be focused and deflected in a series of powerful electromagnets into an experimental area 25 feet from the accelerator. The machine will be equipped with a unique switching magnet that will make it possible to shift the particle beam into any one of five directions, depending on the type of study under way. The accelerator will incorporate a unique method of charge exchange whereby the electric charge of a nuclear particle is changed during its acceleration to very high speeds, permitting the same 5-million-volt potential to impart the equivalent of a 10-million-volt speed to the particle.

This system of particle acceleration was originally invented by Willard H. Beams, formerly of Ohio State University and now at Naval Research Laboratory in Washington. It was rediscovered by Luis W. Alvarez of the University of California who produced a 1-million-volt model of this machine, which he called a "swindletron." Essential to the operation of the tandem-style Van de Graaff accelerator is a source of negatively charged hydrogen ions. Credit for the development of such a source is due to R. G. Herb and his associates at the University of Wisconsin. With Herb's source, positive hydrogen ions are made negative before being accelerated into the Van de Graaff. At the halfway point of acceleration, negative ions are stripped of their excess electrons so that they can accelerate "downhill" using the same high voltage. The machine will be developed and built by the High Voltage Engineering Corporation, Cambridge, Mass.

News Briefs

■ The Air Research and Development Command has begun a new study of the jet stream, a current of wind from west to east at altitudes ranging from 25,000 to 40,000 feet; it sometimes attains speeds of more than 250 miles per hour. During the winter months the jet stream frequently occurs over the southern United States, and past tests have used aircraft based in Florida. For the new study, the base of operations has been moved to Wright-Patterson AFB, Ohio, since in the summer months the stream frequently occurs over the northern United States and southern Canada.

The jet stream will be charted by a specially equipped B-47 bomber. It is hoped that it will prove possible to develop more accurate methods of forecasting these winds, so that jet aircraft operating at high altitudes will be able to ride the jet stream.

■ A hydraulics laboratory built at a cost of $125,000 by the Government of India with the aid of the United Nations Educational, Scientific and Cultural Organization is now operating at the Indian Institute of Technology at Kharagpur, 72 miles from Calcutta. Plans for the laboratory were drawn up by Otto Walch, a German engineer and university teacher, who has just completed a 4-year mission to India under the UNESCO technical assistance program.

In the new laboratory, water from a 60,000-gallon tank is pumped through seven flumes—steel troughs varying from 20 to 60 feet in length and equipped with thick plate-glass observation windows in their sides—in order to permit study of the behavior of scale models of dams, locks, canals, and other forms of waterway construction. Delicate measuring instruments have been supplied to the laboratory with the aid of a $30,000 UNESCO grant. As professor of hydraulics and dam construction in the civil engineering department at Kharagpur, Walch had 170 undergraduate students and 20 postgraduate students, nine of whom were specializing in dam construction.

Scientists in the News

HARRY S. COLEMAN, who has been a member of the executive staff of Mellon Institute for 38 years, retired on 30 June from active service. During 1929–37 he was in charge of the planning, engineering features, and constructing of the institute's building. Subsequently he wrote two brochures on research laboratory design, erection, and equipment, and edited a comprehensive treatise entitled *Laboratory Design*, issued in 1951 under the auspices of the National Research Council. Coleman, who was born in Colony, Kan., in 1886, received his professional mechanical engineering education at the University of Kansas.

EDWARD H. SMITH will retire in August from his post as director of the Woods Hole Oceanographic Institution.

H. R. SENF, formerly head of the electronics laboratory in the Missile Systems Division of the Lockheed Aircraft Company, has recently joined the Research and Development Laboratories of the Hughes Aircraft Company at Culver City, Calif. There he heads the experimental systems section of the electronics department.

LEONARD A. SCHEELE Surgeon General of the United States, will resign on 1 Aug. to become president of the Warner-Chilcott Laboratories, a subdivision of the Warner-Lambert Pharmaceutical Company, with offices in Morris Plains, N.J. Scheele stated that he was resigning ". . . in the interest of providing more properly for the security of my family."

HORACE W. MAGOUN, professor of anatomy at the University of California in Los Angeles, has received the Jacoby award of the American Neurological Association. He was honored for his work in basic neurology.

REUBEN L. KAHN has retired after 27 years of service to the University of Michigan as professor of serology in the medical school and director of serologic laboratories in the university hospital. Discoverer of the test for syphilis that bears his name, Kahn plans to devote himself full time to research. His interests include the serology of syphilis, a universal blood test which he developed several years ago, and the role of the body tissues in immunity.

COLIN M. MACLEOD, chairman of the department of microbiology at New York University College of Medicine since 1941, has been appointed John Herr Musser professor of research medicine and chairman of that department in the School of Medicine of the University of Pennsylvania. His special fields of interest are infectious diseases, microbial genetics, and immunology. MacLeod succeeds WILLIAM C. STADIE, who retired as emeritus professor on 30 June.

VLADIMIR WALTERS has been named assistant curator of fishes at the American Museum of Natural History, New York. A research associate in the museum's department of fishes since October 1955, Walters completed 2 years of service with the U.S. Army Chemical Corps in May 1956. He is a specialist in the zoogeography of arctic fishes and has conducted research on the climatic adaptation of arctic and tropical plants and animals.

Walters will work on a special project for the Office of Naval Research, investigating the metabolic efficiency of large, fast-swimming marine fishes. The study, which will last about 3 years, is expected to provide further insight into the movements of objects through media of various densities. This use of biological models to study hydrodynamic characteristics may affect the design of future sea and aircraft.

JOHN A. SCHILLING, assistant professor of surgery at the University of Rochester School of Medicine and Dentistry, has been named professor of surgery and chairman of the department at the University of Oklahoma.

The following members of the Columbia University faculty have retired: WALTER H. BUCHER, Newberry professor emeritus of geology; HANS T. CLARKE, professor emeritus of biochemistry; WALTER A. CURRY, professor emeritus of electrical engineering; HENRY E. GARRETT, professor emeritus of psychology; MICHAEL HEIDELBERGER, professor emeritus of immunochemistry; JOSEPH SCHROFF, William Carr professor emeritus of oral surgery; and ALAN DE FOREST SMITH, professor emeritus of orthopedic surgery.

RICHARD COURANT, head of the graduate mathematics department at New York University and scientific director of the university's Institute of Mathematical Sciences, has been elected to foreign membership in the Royal Netherlands Academy of Sciences and Letters "in view of the great esteem in which he is held by its members."

Another member of the institute staff has also been honored recently. JAMES J. STOKER, JR., associate director, received the $5000 Dannie Heineman prize for his two books, *Non-Linear Vibrations* and *Theory of Water Waves*. The award committee characterized the two volumes as "outstanding contributions to the field of classical mathematical physics and mechanics."

WILLIAM H. ZACHARIASEN, professor of physics at the University of Chicago, has been appointed chairman of the department. Zachariasen, a specialist in x-ray crystallization, succeeds ANDREW W. LAWSON, professor of physics, whose 3-year term as chairman has expired.

JOHN KIRTLAND WRIGHT, director of the American Geographical Society from 1938 to 1949 and a member of its staff since 1920, retired on 1 July. Wright's many contributions to the field of geography have been recognized by several awards in recent years—the Charles P. Daly medal of the American Geographical Society in 1954, the Patron's medal of the Royal Geographical Society in 1955, and the Outstanding Achievement award of the Association of American Geographers in 1956.

RAYE R. PLATT, who joined the society's staff in 1921 and was for many years associated with its Millionth Map of Hispanic America program, also retired on 1 July. During his long service with the society, Platt edited a number of books in its Special Publications and Research Series and most recently has directed the preparation of a series of geographic handbooks on strategic countries, sponsored by the Office of Naval Research.

DAVID LOWENTHAL, formerly chairman of the department of geography at Vassar College, and WILLIAM WARNTZ, assistant professor of economics and geography at the Wharton School of Finance and Commerce, University of Pennsylvania, have accepted appointments as research associates on the staff of the American Geographical Society as of 1 July.

RAYMOND K. APPLEYARD, a British physicist; HENRI P. JAMMET, French radiologist; and EIZO TAJIMA, physics professor from Rikkyo University in Japan, have been appointed to serve on the staff of the United Nations Scientific Committee on the Effects of Atomic Radiation. They will do preparatory work on reports submitted by governments for the consideration of the committee at its meeting on 22 Oct.

JOSEPH C. AUB will retire this summer as professor of research medicine, Harvard University; as chairman of the department of medicine, Harvard Medical School; and as director of the medical school's laboratories in the Collis P. Huntington Memorial Hospital. He will become professor of research medicine, emeritus. Aub was one of the first medical investigators to point out that studies of normal cells could lead to an understanding of abnormal cell growth, including cancer.

As a member of the Cancer Commission of Harvard University, Aub directed research in the roles played by glands of internal secretion in the control of cell growth. The commission's activities are primarily centered in the Huntington Memorial Hospital.

Aub's early research (1917–25) in basal metabolism, led to the discovery of the importance of calcium metabolism in lead colic ("painter's colic") and to investigation of the entire problem of lead poisoning and calcium metabolism in man.

As a teacher, Aub is regarded by his colleagues as having great and continuing influence on both medical students and graduate students. His students are to be found in leading academic roles throughout the world.

Recent Deaths

FLOUENCE CROWLEY, Chester, Pa.; 72; design engineer; 30 June.

WINFRED M. HARTSHORN, New York, N.Y.; 82; emeritus professor of pediatrics at the New York Polyclinic Medical School and Hospital; 2 July.

JAMES D. McCLINTOCK, Pound Ridge, N.Y.; 55; mining engineer; 2 July.

EDGAR M. MEDLAR, Ithaca, N.Y.; 69; principal pathologist for the New York State Tuberculosis Service at Herman Biggs Hospital in Ithaca; research expert on tuberculosis; 30 June.

OSCAR G. MELCHIOR, Ridgewood, N.J.; 58; mechanical engineer;

foreign projects manager for M. W. Kellog Company; 1 July.

CARL T. SCHWARZE, Greer, S.C.; 78; emeritus professor of civil engineering at New York University; 28 June.

HOMER R. SEELY, Woodbury, N.J.; 58; civil engineer; 23 June.

JOSEPH F. TAYLOR, Rochester, N.Y.; 67; chairman of the board and former president of the Bausch & Lomb Optical Co., 13 June.

EMANUEL WALDINGER, Old Saybrook, Conn.; 57; former medical director of the Saybrook Rehabilitation Center; 30 June.

PHILIP ZENNER, Cincinnati O., 104; professor emeritus of neurology at the University of Cincinnati; 25 June.

Education

■ The Carnegie Corporation of New York has awarded $277,000 to the University of Illinois Committee on School Mathematics so that it may continue its work of devising a new mathematics course for the four high-school years, preparing classroom materials and teachers' manuals, and conducting teacher training courses on new teaching techniques to be developed. The 4-year-old program, in which mathematics is treated as an integrated body rather than as a group of isolated courses, is directed by a committee composed of representatives of the colleges of education, engineering, and liberal arts and sciences at Illinois. Its staff is already experimenting with curriculum changes for high-school freshman, sophomore, and junior classes, and is testing new materials in five different high schools in Illinois and Missouri, with the cooperation of 14 teachers and almost 500 students.

■ The department of natural sciences of Hofstra College has announced that in September the department of geology will become the department of geology and geography. Roger H. Charlier, now acting chairman of the department of geology, will become chairman of the new department.

■ A recent innovation at the Worcester Foundation for Experimental Biology, Shrewsbury, Mass., has been its Summer Science Program for high school students. This involves a collaborative arrangement with St. Marks School in Southboro, Mass., wherein selected students are lodged at the school for a 10-week term.

An intensive course of lectures and laboratory work in chemistry and biology is given to a junior group in the first summer. In a second summer the group which has had the first summer's work is assigned to the foundation laboratories for work on specific research problems. This is part of a program designed to interest secondary school students in a scientific career.

Grants, Fellowships, and Awards

■ The John A. Hartford Foundation has granted $159,000 to the New York University–Bellevue Medical Center to support studies of pancreatitis, a disease that, in acute form, has a mortality rate of about 50 percent.

■ The first payment by the Ford Foundation under its endowment program to help raise faculty salaries was made the first week in July. Six hundred thirty colleges and universities received checks totaling $130 million, which is half of the total grant. The program includes all 4-year regionally accredited, privately supported colleges and universities that offer degrees in the liberal arts and science or bachelor's degrees in professional fields. In a second program, 126 of these institutions will receive accomplishment grants as well.

■ The Philadelphia College of Physicians and Surgeons has awarded the 1956 Alvarenga prize to G. N. Papanicolaou, Cornell University Medical College, for his work in the early detection of cancer. Pedro Francisco DaCosta Alvarenga of Lisbon, Portugal, established the prize to be awarded yearly on the anniversary of his death, 14 July 1883.

■ The Population Council, Inc. of New York is offering fellowships for advanced training in the study of population at the predoctoral and postdoctoral levels. Fellowships are available for study both in the United States and abroad; the awards will be divided between students from the United States and those from other countries. An applicant may select his own university.

Fellows will normally receive support for full-time study for a period of 1 year. The basic stipend of $2500 per year may be supplemented to provide for maintenance of dependents, and especially in the case of foreign students, for travel and exceptional expenses. The amount may be diminished in accordance with lesser need or partial support from other sources. Somewhat larger stipends may be granted to postdoctoral than to predoctoral fellows.

Preference will be given to candidates who are not over 40 years of age. Applications for 1957–58 should be received *before 1 Mar. 1957*. Requests for further information and for application forms should be addressed to the Population Council, Inc., 230 Park Ave., New York 17, N.Y.

■ The American Academy of Arts and Sciences invites applications for grants from its Permanent Science Fund. Awards are made in support of research in any field of science whatsoever in amounts that ordinarily do not exceed $1500. Applications for grants to be made in the early fall should be filed *by 1 Sept.* on forms available from the Chairman, Permanent Science Fund Committee, American Academy of Arts and Sciences, 77 Massachusetts Ave., Cambridge 39, Mass.

Special consideration will be given to projects on new frontiers of science; those that lie between, or include, two or more of the classical fields; and those proposed by investigators who may be on the threshold of investigational careers or who are handicapped by inadequate resources and facilities. The committee does not ordinarily approve grants for research the results of which constitute partial fulfillment of requirements for an academic degree.

■ The Research Corporation has granted $247,775 for basic research in science to 72 colleges and universities in the United States and three in Canada. The corporation, which was established in 1912 by F. G. Cottrell, has distributed a total of $8.5 million.

■ New York University has received a grant of $70,000 from the Rockefeller Foundation in support of a study of public attitudes toward science reporting. The project, which is an extension of a pilot study begun last year, is jointly sponsored by the university and the National Association of Science Writers.

■ Forty fellowships for graduate students specializing in services for the blind have been established by Columbia University and the New York Guild for the Jewish Blind. Recipients will get $1200 for each of 2 years of study. They will be enrolled at the university's New York School of Social Work and will attend workshop classes at the guild center. The $96,000 program is to be offered over a 5-year period beginning this fall, when six students will be admitted to study under the plan.

In the Laboratories

■ The formation of the first scientific organization in the United States designed expressly to conduct research and development in interplanetary space travel has been announced by John L. Barnes, president of the newly established Systems Laboratories Corporation, Los Angeles, Calif. Barnes is a professor of engineering at the University of California, Los Angeles. The corporation has been

organized especially to overcome the technical obstacles that still stand in the way of man's first flight to the moon.

■ A division for theoretical physics under the leadership of Conyers Herring has been formed in the physical research department of the Bell Telephone Laboratories, New York. In addition to a number of theoretical physicists already at Bell, the new department will have as members M. Lax, formerly of Syracuse, J. C. Phillips of Chicago, and A. D. Brailsford of Birmingham.

■ The Union Carbide and Carbon Corporation plans to build a $28.5-million plant in Puerto Rico to make thylene glycol, best known to the layman as a principal ingredient of "permanent" antifreezes. It also is used as a moistening agent for dynamite in low-temperature conditions, and as a moistening agent and conditioner in cigarette packaging.

Miscellaneous

■ A comprehensive guide to information on international migration for 24 countries has been published by the United Nations. The countries were chosen with a view to facilitating studies of emigration from Europe. The 200-page volume, entitled *Analytical Bibliography of International Migration Statistics, Selected Countries, 1925–1950,* was prepared by the Population Branch of the U.N's Bureau of Social Affairs, with the help of the United Nations Library, the Library of Congress, the U.N. Statistical Office, and the Statistical Division of the International Labor Office.

It meets in part requests by the U.N. Population Commission and the Economic and Social Council for means to improve statistics on international migration in order "to increase their adequacy and comparability." All information compiled for a given country was sent to the government of that country for completion or correction. As a result, in several instances, governments made additional data available for inclusion in the publication. The new bibliography is on sale for $2 per copy at the U.N. Bookshop and all other sales agents for U.N. publications.

■ The Southern Research Laboratory, U.S. Department of Agriculture, is expanding its research program to improve the quality of cotton fiber, yarns, fabrics, and textiles, and to produce products with greater utility in such fields as surface coatings, plasticizers, printing inks, and many other industrial fields. Research is also being carried out on pine gum, turpentine, and rosin. Chemists are needed to conduct research in the solution of public problems in the fields of agricultural development and utilization of agricultural commodities, by-products, and residues, and in the creation of improved foods, feeds, drugs, fabrics, industrial chemicals and other inedible products.

Chemists with specialization in the fields of analytical, organic, physical, inorganic, and biochemistry are invited to apply for positions with federal agencies located in Texas, Oklahoma, Louisiana, and Arkansas. Salaries range from $5440 to $10,320 per annum. Application form SF-57, which may be obtained at most post offices, should be submitted to the Director, Eighth U.S. Civil Service Regional Office, 1114 Commerce Street, Dallas, Tex.

■ Acting under a law that permits higher salaries when the Federal Government finds its scale too low to compete effectively with private industry, the U.S. Civil Service Commission has authorized increases of from $135 to $1075 a year in starting pay for engineers, scientists, and certain specialists. The commission expects that federal agencies will be able to recruit 4700 additional employees in these categories by the aid of the more attractive salary scales. Some 30,000 government workers will also benefit by the general increase, the total cost of which will be about $12 million annually.

■ The National Academy of Sciences–National Research Council has announced the availability of a second edition of *Baccalaureate Origins of Science Doctorates Awarded in the United States,* which was compiled by the Office of Scientific Personnel, under the direction of M. H. Trytten. The first edition covered the period 1936–1945; the current publication extends the work through 1950. The study was undertaken for the purpose of identifying all doctoral degrees granted in the natural sciences, by institution and field of specialization, from the beginning of 1936 on, and to determine where and when the first (usually baccalaureate) degrees were obtained.

The new volume, which costs $2, presents in tabular and graphic form the product of 10 years of research begun early in 1946. A few of the many questions it answers are as follows: (i) How many doctorate degrees in the natural sciences were granted in the United States between 1936 and 1950? How many were granted in each field? (ii) What are the annual trends in the national production of doctorates in the various sciences? (iii) Where are the doctorates in the natural sciences obtained? What sections of the United States furnish the most scientists? What sections furnish the fewest? (iv) What institutions granted the largest number of doctorates between 1936 and 1950? What institution granted the largest number in chemistry? physics? psychology? engineering? zoology? (v) What colleges most effectively stimulate the interest of their students in the natural sciences, as evidenced by continued studies culminating in the doctorate? (vi) What institution ranked highest in the production of young scholars who took the doctorate between 1936 and 1950?

■ The Lincoln Laboratory at Massachusetts Institute of Technology has issued a brochure describing current opportunities in physics, electrical engineering, mathematics, and psychology. Doctors and graduate engineers interested in working on classified projects may secure a copy of the bulletin by writing: Research and Development, M.I.T. Lincoln Laboratory, Box 24, Lexington, Mass.

■ U.S. Atomic Energy Commission research reports are now available in eight category "packages." Prices take into account reduced handling costs made possible by bulk packaging. The categories are health, physics, biology and medicine (220 reports); chemistry (455 reports); engineering (105 reports); geology and mineralogy (144 reports); instruments (292 reports); metallurgy and ceramics (380 reports); physics (1190 reports); miscellaneous (55 reports). For information, write to Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

■ The U.S. State Department's traveling exhibit, "Atoms-for-Peace," consisting of model reactors and a variety of atomic equipment, has, according to the *New York Times,* had considerable success in Hiroshima, Japan. About 120,000 people have visited the exhibit, a notably large attendance in a city of some 380,000 inhabitants.

■ The Priestley Memorial Association of Northumberland, Pa., will restore and maintain the home of Joseph Priestley, noted 18th-century divine and chemist, as a national shrine. The home, formerly owned by Pennsylvania State University, has been transferred to the custody of the Borough of Northumberland. Priestley's crude laboratory in which he continued experiments begun in England is attached to the house. It was here that he isolated carbon monoxide.

Help in providing funds for refurnishing and maintaining the house will be welcomed by the memorial association. Communications should be addressed to R. L. Davis, Director, Priestley Memorial Association, 306 Water St., Northumberland, Pa.

Reports

Accumulation of Reduced Pyridine Nucleotides by Illuminated Grana

The ability of illuminated chloroplasts to reduce pyridine nucleotides has previously been demonstrated indirectly by coupling the photochemical process with a suitable dehydrogenase and measuring the formation of the product of the dehydrogenase system (*1, 2*). However, up to the present time, no accumulation of reduced pyridine nucleotides by illuminated grana or chloroplasts has been reported. It has heretofore been suggested (*2, 3*) that the inability of pyridine nucleotides to undergo directly measurable photochemical reduction may be a consequence of their low oxidation-reduction potential (E_0' at pH 7.0 = −0.32 v) since most substances that are effective as oxidants in the Hill reaction have high oxidation-reduction potentials (E_0' at pH 7.0 = +0.1 to +0.4 v). In this paper (*4*), data are presented which show that, under the proper conditions, photochemical reduction of pyridine nucleotides can indeed be demonstrated directly.

The results of a typical experiment are presented in Table 1 (*5*). The data clearly indicate that, when diphosphopyridine nucleotide (DPN) is incubated with grana in the light, either aerobically or anaerobically, reduced DPN (DPNH) accumulates in the reaction mixture. It can be seen that more DPNH is formed under anaerobic conditions than aerobically. Further, no reduction of DPN occurs in the dark under aerobic conditions. In separate experiments it has been established that this reduction is light-dependent even under anaerobic conditions.

Table 1. Reduction of DPN by illuminated grana aerobically or anaerobically.

Conditions	Amount of DPNH formed (μmole)
Aerobic-dark	0
Aerobic-light	6.7
Anaerobic-light	19.8

Table 2. Effect of DPN concentration.

Amount of DPN initially present (μmole)	Amount of DPNH formed (μmole)
13.3	8.1
26.6	16.7
39.9	21.8

The effect of the concentration of DPN initially present in the reaction mixture on the amount of DPNH formed is illustrated by the data presented in Table 2 (*6*). It can be seen that the amount of DPNH formed is almost directly proportional to the amount of DPN present initially. It does not appear that we have reached a saturating level of DPN even at an initial concentration of DPN of about $4 \times 10^{-3} M$.

In one experiment, which was carried out anaerobically in the light for 125 minutes, it was possible to show the accumulation of 34 μmole of DPNH, which corresponds to about 85 percent of the DPN present initially.

Triphosphopyridine nucleotide (TPN) and the acetylpyridine analog of DPN (AP-DPN) are also reduced by illuminated grana, although to a lesser extent than is DPN. When the reduction process is carried out aerobically in the light, the amounts of reduced TPN and reduced AP-DPN formed correspond to approximately 60 percent and 40 percent, respectively, of the amount of DPNH formed (*7*). Under identical conditions, nicotinamide mononucleotide is not reduced to any measurable extent. It is interesting that the amount of reduction observed with AP-DPN is less than that with DPN, even though the oxidation-reduction potential of AP-DPN is about 0.08 v more positive than that of DPN (*8*). The finding that nicotinamide mononucleotide was not reduced indicated that the reduction is an enzyme-catalyzed reaction and that the enzyme is highly specific for the intact dinucleotide structure.

The stereospecificity exhibited by the enzyme that catalyzes the reduction is different from that responsible for the oxidation of the reduced pyridine nucleotides, since deuterium from the medium is incorporated into the oxidized pyridine nucleotides by illuminated grana (*9*). The deuterium has been shown to be present at that position of the pyridine nucleotide which undergoes reversible oxidation-reduction (*10, 11*).

It has been observed that at low grana concentrations—that is, less than 0.06 mg of chlorophyll per milliliter—no measurable reduction of DPN takes place, even when the initial concentration of DPN is about $3.8 \times 10^{-3} M$. This finding might explain why previous investigators have not observed the reduction of DPN.

Recent experiments indicate that it is possible to demonstrate reduction of pyridine nucleotides under these conditions of low grana concentration, provided that a soluble extract from chloroplasts is added. A description of this extract is in preparation.

The accumulation of DPNH by illuminated grana is difficult to interpret in terms of known oxidation-reduction potentials if the reduction is a 1-quantum process. If the reduction of DPN is pictured as proceeding according to Eq. 1, then the energy required for this reaction is approximately +52 kcal/mole.

$$DPN^+ + H_2O \rightarrow DPNH + H^+ + \tfrac{1}{2} O_2 \quad (1)$$

Since the energy content of 1 einstein (6×10^{23} quanta) of red light is about 44 kcal, it is evident that the reduction of DPN by illuminated grana would proceed only to a very small extent at pH 7. Arnon (*12*) has calculated that the energy of 1 quantum of red light is sufficient to maintain the ratio of DPNH/DPN at 10^{-5} at pH 7.0 and an oxygen tension of 0.2 atm. The results presented here are inconsistent with this calculation. It would appear, therefore, that the reduction of DPN by illuminated grana requires more than 1 quantum of red light. Since the reduction of DPN is a 2-electron process, it is possible that the reaction requires 1 quantum per electron transferred to the DPN. This does not necessarily imply that the reaction proceeds through a free radical intermediate, since Barltrop *et al.* (*13*) have presented a mechanism for reduction of DPN via thioctic acid which requires 2 quanta of red light per molecule of DPNH formed.

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References and Notes

1. W. Vishniac and S. Ochoa, *Nature* **167**, 768 (1951); L. J. Tolmach, *ibid.* **167**, 946 (1951); D. I. Arnon, *ibid.* **167**, 1008 (1951).
2. W. Vishniac and S. Ochoa, *J. Biol. Chem.* **195**, 75 (1952).
3. A. Mehler, *Arch. Biochem. and Biophys.* **33**, 65 (1951).
4. Contribution No. 142 of the McCollum-Pratt Institute. This investigation was supported by a research grant [RG-4143 (C)] from the National Institutes of Health, U.S. Public Health Service. We wish to express our gratitude to S. P. Colowick for many helpful suggestions.
5. The "grana" were prepared as follows: 25 g

of spinach leaves were deveined and ground for 3 min in a Waring Blendor with 200 ml of cold 0.01*M* Na_2HPO_4-KH_2PO_4 buffer of *p*H 7, containing 0.01*M* KCl. After filtering through cheesecloth, the filtrate was centrifuged for 2 min at 4600*g*. The supernatant was centrifuged for 20 min at 18,000*g*; the residue was suspended in buffer and centrifuged again at 18,000*g*. The final residue was made up in 0.05*M* Na_2HPO_4-KH_2PO_4 buffer of *p*H 7, containing 0.01*M* KCl. No attempt has been made to ascertain that this preparation consists solely of grana. Each reaction mixture contained grana equivalent to 4.92 mg of chlorophyll, 38.1 μmole of DPN, 500 μmole of Na_2HPO_4-KH_2PO_4 buffer of *p*H 7.05, and 100 μmole of KCl. The final volume was 10 ml. The dark control flask was wrapped with tinfoil. The anaerobic flask was evacuated continuously with a water aspirator, and the aerobic flask was open to air. The flasks were incubated for 10 min in the dark and for 60 min in the light (one 100-w bulb per flask at a distance of approximately 6 in.) with shaking at 13 to 14°C. After incubation, the samples were centrifuged to remove the grana, and the DPNH concentration in the supernatant solution was determined by measuring the decrease in optical density at 340 mμ upon the addition of acetaldehyde and yeast alcohol dehydrogenase.

6. Each reaction mixture contained grana equivalent to 4.34 mg of chlorophyll, DPN, 500 μmole of Na_2HPO_4-KH_2PO_4 buffer of *p*H 6.98, and 100 μmole of KCl. The final volume was 10 ml. The flasks were incubated aerobically for 80 min in the light with shaking at 12°C. After incubation, the samples were treated as indicated in Table 1.
7. Reduced TPN and reduced AP-DPN were estimated spectrophotometrically from their absorption at 340 mμ and 365 mμ, respectively. The extinction coefficient of reduced AP-DPN has been determined by N. O. Kaplan and M. M. Ciotti [*J. Biol. Chem.*, in press].
8. N. O. Kaplan, M. M. Ciotti, F. Stolzenbach, *J. Biol. Chem.*, in press.
9. A. San Pietro and H. M. Lang, in preparation.
10. M. E. Pullman, A. San Pietro, S. P. Colowick, *J. Biol. Chem.* **206**, 129 (1954).
11. The results of this study are in preparation.
12. D. I. Arnon, *Science* **122**, 9 (1955).
13. J. A. Barltrop, P. M. Hayes, M. Calvin, *J. Am. Chem. Soc.* **76**, 4348 (1954).

6 April 1956

"Adenoviruses": Group Name Proposed for New Respiratory-Tract Viruses

The discovery of a new group of viruses, affecting primarily the respiratory tract, has led to the need for a meaningful, specific, and acceptable name for these agents, both as viruses and in relation to diseases with which they are associated. In the first published report of the isolation of these viruses, Rowe and his associates (*1*) used the term *adenoid degeneration agent*, abbreviated as *A.D. agent*. The 13 strains reported at that time were recovered from human adenoids removed surgically and cultivated in tissue culture. Independently, Hilleman and Werner (*2*) reported the isolation of five agents, termed *Respiratory illness* (*RI*) *agents*, during an epidemic of acute respiratory disease (ARD) and pneumonitis among recruits at Fort Leonard Wood, Mo. One of these agents (strain RI-67) was shown by complement-fixation and neutralization tests to be etiologically associated with the epidemic disease (*2*). Confirmation and expansion of their findings soon followed (*3–5*). Further information was rapidly acquired (*6–22*), indicating that these viruses comprised a family or group and that they were related to several clinical syndromes. Huebner and his associates (*6*) proposed the term *adenoidal-pharyngeal-conjunctival* (*APC*) agents or viruses as the group name.

The problem of terminology was discussed informally for some months by investigators and others interested in the field at the National Institutes of Health, at Walter Reed Army Institute of Research, at several universities both in this country and abroad, and by members of such groups as the Scientific Advisory Committee of the Common Cold Foundation. These discussions culminated in a meeting in New York City on 25 May 1956 of the undersigned representatives of the early investigators in the field and others interested in seeking a satisfactory solution to the problem.

Agreement was reached on the term *adenovirus group*, which suggests a characteristic involvement of lymphadenoid tissue (*23*), as well as the tissue of the first reported isolation, and is in accordance with the proposals concerning nomenclature of the Subcommittee on Viruses of the International Nomenclature Committee (*24, 25*). For the present, members of the group would be indicated by serotype numbers in accordance with the classification of Huebner *et al.* (*6, 9*). Thus far, 12 types have been reported from human and two from simian sources (*9*). Information is not yet available to permit a completely detailed description of the adenovirus group. The viruses at present included in this group, however, have the following characteristics. (i) They produce acute infection of respiratory and ocular mucous membranes with associated follicular enlargement of submucous lymphadenoid tissue in these areas and also of the regional lymph glands. Virus has frequently been isolated from adenoid or tonsillar tissues from persons without clinical signs of acute illness. (ii) Multiplication in tissue culture of certain types of human and simian cells takes place readily and leads to increased acid formation and distinctive cytopathic changes. As is shown by electron micrographs, the nuclei of virus-infected cells may contain symmetrical arrays of virus-like particles. (iii) An antigen unique to this group, demonstrable in the complement-fixation test, is shared by members of the family. (iv) Antigenic type specificity is demonstrable by the neutralization test. (v) No strain as yet has produced manifest illness in commonly used laboratory animals.

With respect to terminology of the diseases caused by these viruses, it is proposed that the usual practice be followed of employing a clinical diagnostic term followed by etiological identification, such as, for example, acute respiratory disease (ARD) caused by adenovirus type 4; pharyngitis or pharyngoconjunctival fever caused by adenovirus type 3; follicular conjunctivitis caused by adenovirus type 6; keratoconjunctivitis caused by adenovirus type 8; or pneumonitis or atiypical pneumonia caused by adenovirus type 7. The use of such terminology will eliminate confusion that might arise from the facts that a single serotype can produce clinically different diseases and, conversely, that clinically similar illnesses may be produced by different adenovirus serotypes as well as by unrelated agents.

In making the foregoing proposals regarding terminology, the undersigned realize that they have no official status conferred by any national or international body dealing with nomenclature. They have, however, found that the term *adenovirus group* is acceptable among the investigators most concerned. Accordingly, it is suggested that this designation be generally employed in the interest of avoiding further confusion in the literature until ultimately a satisfactory nomenclature can be established for viruses.

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References and Notes

1. W. P. Rowe *et al.*, *Proc. Soc. Exptl. Biol. Med.* **84**, 570 (1953).
2. M. R. Hilleman and J. H. Werner, *ibid.* **85**, 183 (1954).
3. J. H. Dingle *et al.*, *Trans. Assoc. Am. Physicians* **67**, 149 (1954).
4. H. S. Ginsberg *et al.*, *J. Clin. Invest.* **34**, 820 (1955).
5. M. R. Hilleman *et al.*, *Am. J. Public Health* **45**, 203 (1955).
6. H. J. Huebner *et al.*, *New Engl. J. Med.* **251**, 1077 (1954).
7. W. P. Rowe *et al.*, *Am. J. Hyg.* **61**, 197 (1955).
8. M. R. Hilleman, J. H. Werner, M. T. Stewart, *Proc. Soc. Exptl. Biol. Med.* **90**, 555 (1955).
9. W. P. Rowe, J. W. Hartley, R. J. Huebner, *ibid.* **91**, 260 (1956).
10. R. H. Parrott *et al.*, *New Engl. J. Med.* **251**, 1087 (1954).

11. J. A. Bell *et al., J. Am. Med. Assoc.* **157**, 1083 (1955).
12. M. R. Hilleman, A. J. Tousimis, J. H. Werner, *Proc. Soc. Exptl. Biol. Med.* **89**, 587 (1955).
13. H. S. Ginsberg *et al., Am. J. Public Health* **45**, 915 (1955).
14. M. R. Hilleman *et al., Am. J. Hyg.* **61**, 163 (1955).
15. M. R. Hilleman *et al., ibid.* **62**, 29 (1955).
16. T. O. Berge *et al., ibid.* **62**, 283 (1955).
17. T. G. Ward *et al., Science* **122**, 1086 (1955).
18. E. Jawetz *et al., ibid.* **122**, 1190 (1955).
19. F. A. Neva and J. F. Enders, *J. Immunol.* **72**, 315 (1954).
20. L. Kjellen, *Arch. ges. Virusforsch* **6**, 45 (1955).
21. L. Kjellen *et al., Nature* **175**, 505 (1955).
22. C. G. Harford, A. Hamlin, E. Parker, *Soc. Am. Bacteriologists Proc. 1955*, p. 64.
23. Older usage applied the term *adenoid* to a variety of glandlike lymphatic or lymphoid tissues in addition to the nasopharyngeal adenoids.
24. Report of the Subcommittee on Viruses, *Intern. Bull. Bacteriol. Nomenclature and Taxonomy* **4**, 109 (1954).
25. C. H. Andrewes, chairman of the Subcommittee on Viruses of the International Nomenclature Committee has signified to us his approval of the name *adenovirus*, indicating that it offers a great advantage and can be readily integrated with the proposed system of the Committee for Virus Nomenclature.

19 June 1956

Encoding Nonintegers in a General p-adic Number System

Without doubt the most common number system in use is the decadic system, which is more often called the decimal system and in which ten basic numbers (*base* or *radix* ten) 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 are used. But the decadic system is by no means the only possible number system. In fact, it is not even necessary that the radix of a number system be equal to or less than ten; it can be greater than ten. As an example, consider the number system with radix 11. Here a new symbol, say α, must be created as the eleventh basic number in addition to the ten in the decadic system, making the new list of basic numbers as follows: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, α. If one wishes to express the number 360 in this new system, one would have: $(360)_{10} = (2\alpha 8)_{11}$. We will call the number system with a radix p a p-adic number system.

Methods of converting integers in the decadic system to expressions in other number systems and vice versa by means of Euclid's algorithm are well known. However, little information seems to be available for converting nonintegers, numbers with decimal places in the decadic system. This note presents ways for encoding an arbitrary nonintegral number and a rational fraction in a general p-adic system.

Suppose it is desired to encode a nonintegral number in the decadic system into one in a p-adic system. The integral and decimal parts (parts preceding and following the decimal point, respectively) of the number must be converted separately. Euclid's algorithm or the continued division process can be applied to both parts, but the methods of application are different. For the integral part, the process is to perform successive divisions by p and collect the remainders in the reverse order; for the decimal part, it is necessary to perform successive divisions by p^{-1} and collect the remainders in the forward order. As an example, assume that $(7.3125)_{10}$ is to be encoded in the diadic system (radix 2). We will find that

$$(7)_{10} = (111)_2$$

and

$$(0.3125)_{10} = (0.0101)_2$$

Hence

$$(7.3125)_{10} = (111.0101)_2$$

It may also be proved that this conversion is unique.

It is clear that for integral numbers, the maximum number expressible with n digits in the decadic system is $(10^n - 1)$; this maximum number is $(2^n - 1)$ in the diadic system and $(3^n - 1)$ in the triadic system, and so forth. There is no simple relationship between a decimal number of a given number of digits in the decadic system and the number of necessary digits to express the same number in another system; it depends on the desired accuracy. For example,

$$(3.1416)_{10} = (11.00100100001111111110\ \ldots)_2$$

All *fractionals* (numbers less than one and signified by a fractional point placed at the left of the number) that terminate or repeat cyclically can be expressed as proper rational fractions. Conversely, it is also true that all proper rational fractions can be written as fractionals which terminate or repeat cyclically; the period or cycle of repetition may sometimes be very long. These statements hold for the conventional decadic system as well as for the general p-adic system. Let it be desired to encode the rational fraction $(A/B)_{10}$, where A and B are integers prime to each other and $A < B$, in the diadic system. It is of course possible first to express the integral numerator and denominator, A and B, both in the binary code and then to divide. Division in the diadic system is similar to the operation in the decadic system except that only two basic numbers, 0 and 1, are involved in the former system. However, straightforward division may prove to be a laborious and discouraging process because one does not know when to expect periodicity or how long the period of repetition is, which can indeed be very long. Several important relationships are pointed out in the succeeding paragraphs which will greatly facilitate the encoding process. Reference to the diadic system is not to be taken as a limitation of the relationships.

1) If the denominator B is expressible as an integral power of 2, then the fraction $(A/B)_{10}$ when written as a fractional in the diadic system will terminate. This is easily seen, because if $(B)_{10} = 2^n$, then $(B)_{10} = (1000\ \ldots\ 0)_2$, 1 followed by n zeros in the diadic system. Hence

$$\left(\frac{5}{16}\right)_{10} = (0.3125)_{10} = \left(\frac{5}{2^4}\right)_{10} = \left(\frac{101}{10000}\right)_2 = (0.0101)_2$$

2) If the denominator B is expressible in the form $(B)_{10} = 2^k \cdot m$, where k is any positive integer including zero, and m is prime to 2, then the fraction $(A/B)_{10}$ when written as a fractional in the diadic system will repeat cyclically and indefinitely. This statement can be proved by the use of Euler's theorem on the congruence of numbers in number theory. It can be shown (*1*) that if integer p is relatively prime to integer m, then there are positive exponents s for which

$$p^s = 1 \pmod{m}$$

This expression means that $(p^s - 1)$ is divisible by m. In the language of number theory, one would say that p^s and 1 are congruent modulo m. Rules exist for the determination of the smallest value of the exponent s and the period of the remainders. It suffices to say here that since m is prime to 2, it is possible to determine the smallest value of the exponent s such that $(2^s - 1) = Cm$.

$$\left(\frac{A}{B}\right)_{10} = \frac{A}{2^k \cdot m} = \frac{AC}{2^k(2^s - 1)} = \frac{AC}{2^{k+s}}\left(\frac{1}{1 - 2^{-s}}\right)$$

The last expression can be easily written in the diadic notation; and the appearance of the second factor indicates clearly the existence of an infinite geometric progression with ratio 2^{-s}. As an example, suppose one desires to express the rational fraction $(5/14)_{10}$ as a fractional in the diadic system. Now

$$B = 14 = 2^1 \cdot 7$$

whence $k = 1$ and $m = 7$. It is obvious here that the exponent of 2 modulo 7 (smallest value of s to make 2^s and 1 congruent modulo 7) is 3. Hence $2^3 - 1 = 1 \cdot 7$ with $C = 1$, and

$$\left(\frac{5}{14}\right)_{10} = \frac{5 \cdot 1}{2^{1+3}}\left(\frac{1}{1 - 2^{-3}}\right) = \frac{2^2 + 2^0}{2^4}(1 + 2^{-3} + 2^{-6} + 2^{-9} + \ldots)$$

It follows directly that

$$\left(\frac{5}{14}\right)_{10} = \frac{101}{10000}(1 + 0.001 + 0.000001 + 0.000000001 + \ldots)_2 = (0.0101\mathit{101}101101\ \ldots)_2$$

The italicized part is a typical cycle and it repeats indefinitely.

This method is quite general and is applicable to other systems as well as to the diadic system. If $p = 3$ (triadic system), $B = 14 = 3^0 \cdot 14$ with $k = 0$, $m = 14$. The exponent of 3 modulo 14 is 6 ($s = 6$), and $3^6 - 1 = 52 \cdot 14$, $C = 52$.

$$\left(\frac{5}{14}\right)_{10} = \frac{5 \cdot 52}{3^6}\left(\frac{1}{1 - 3^{-6}}\right) =$$

$$\frac{100122}{1000000}(1 + 0.000001 +$$

$$0.000000000001 + \ldots)_3 =$$

$$(0.100122\mathit{100122}100122 \ldots)_3$$

The expression for $(5/14)_{10}$ as a fractional in the triadic system also repeats indefinitely with the italicized part as its period.

If the numerator 5 is divided directly by the denominator 14 in the decadic system, one has

$$\left(\frac{5}{14}\right)_{10} = (0.3571428\mathit{571428}571428 \ldots)_{10}$$

This is also a periodic affair with the italicized part as its period; it could have been obtained in the same manner as for the diadic and triadic systems illustrated previously. The process of encoding rational fractions into fractionals in the general p-adic system is somewhat more laborious than that of encoding an integer, but it is not necessary that the rational fractions be converted into decimals in the decadic system first.

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Reference

1. See, for instance, J. V. Uspensky and M. A. Heaslet, *Elementary Number Theory* (McGraw-Hill, New York, 1939), Chap. 8.

21 March 1956

Some Serotoninlike Activities of Lysergic Acid Diethylamide

In 1954 Woolley and Shaw (*1*) proposed that serotonin was of importance in the maintenance of normal mental functions. The reason for this idea was that a variety of chemical compounds (ergot alkaloids, harmala alkaloids, yohimbine, certain synthetic analogs of serotonin, and so on) had been found to cause mental disturbance in animals (including man) and could be shown to act as antimetabolites of serotonin when they were tested on smooth muscles. Thus various ergot alkaloids had been shown to act as antimetabolites of serotonin on sections of carotid arteries (*2*) and on isolated rat uteri (*3*). The most active of the ergot derivatives when tested on these isolated tissues was lysergic acid diethylamide (LSD-25).

Because LSD-25 was also remarkable for its high activity in causing hallucinations in human beings (*4*), the aforementioned hypothesis seemed reasonable. The LSD-25 and other hallucinogens, which were demonstrably antimetabolites of serotonin, were pictured as causing their effects on mental processes by bringing about a deficiency of serotonin in parts of the brain. Such pharmacologically produced deficiency of serotonin was evidently the cause of the action of these drugs on the smooth-muscle preparations, and the same explanation might be applied to nerve tissue. Indeed, some of the synthetic antimetabolites of serotonin were shown to act on glial cells of the brain cultured *in vitro* much as they did on smooth-muscle preparations (*5*). However, this idea of the mental effects arising from a deficiency of serotonin in the brain is a working hypothesis. The notion that the drugs bring about a cerebral excess of the hormone, rather than a deficiency, also must be considered (*6*).

We wish now to report some testing procedures in which LSD-25 acted like serotonin rather than as an antagonist. These procedures employed the isolated heart of the clam (*Venus mercenaria*) and the anesthetized dog. Welsh has shown that serotonin stimulates the heart of *V. mercenaria* and causes an increase in the amplitude of the beat. He also reported that this action of the hormone was antagonized by LSD-25 (*7*). We have attempted to repeat this latter observation but have found that, instead of acting as an antiserotonin, LSD-25 (*8*) acted like serotonin. Similar observations have been communicated to us by H. Hoagland. Discussion of our results with Welsh has shown that he now finds the same phenomenon with *V. mercenaria* obtained in America. His earlier findings had been with a European variety. Here, then, is an isolated organ for which LSD-25 acted like serotonin and in which it was more potent, weight for weight, than the hormone itself.

A second situation in which LSD-25 acted like serotonin was in raising the blood pressures of anesthetized dogs. In such animals the intravenous injection of serotonin causes a transient rise in pressure. It is well known that, depending on the dose, the rate of injection, and the individual character of the animal, one may see other responses, such as a fall in arterial pressure preceding the rise, or one may see a sharp rise superimposed on the initial fall, followed by a secondary rise (*6, 9, 10*). This same variability has now been seen in responses to LSD-25. Both pressor and depressor phases could be observed (Fig. 1). Six dogs were anesthetized with Nembutal and calibrated with serotonin as previously described (*10*). They were then tested with graded doses of LSD-25, in-

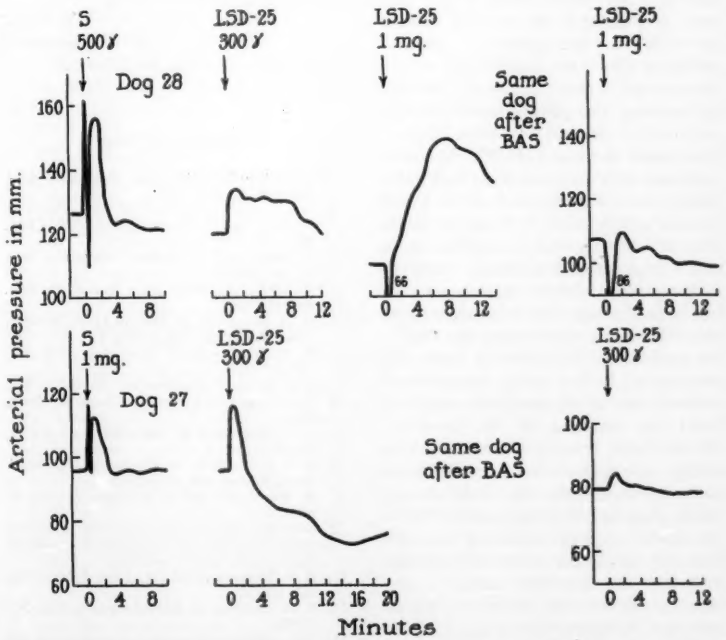

Fig. 1. Arterial pressure responses of dogs intravenously given serotonin (S) and LSD-25 before and after the antimetabolite of serotonin (BAS). Fifty milligrams of BAS was injected intravenously 1 hour before the last dose of LSD-25. Numbers under the profound pressure drops indicate the lowest pressure obtained.

jected into the jugular vein. Quantitative comparison of rises induced by serotonin and by LSD-25 as a pressor agent showed that the LSD-25 was 1 to 3 times as active as serotonin (on a weight basis).

The pressor action of LSD-25 could be prevented by prior treatment of the dog with the new and powerful antimetabolite of serotonin—namely, 1-benzyl-2,5-dimethylserotonin, or BAS (*10, 11*). BAS has been shown to be quite specific, in that dogs protected against serotonin with it are not protected against the pressor effects of adrenaline. The curves will show that BAS protected the dogs against the pressor effects of LSD-25 (*12*).

A third type of experiment in which LSD-25 showed an action similar to that of serotonin has been described by Marrazzi and Hart (*13*). This was the inhibition of synaptic transmission in the optic cortex of the cat. It is therefore clear that one can find both serotoninlike and antiserotonin actions of LSD-25. In fact, both types of effect may be seen in one preparation. Thus, dogs given LSD-25, as in the afore-described experiment, were found to be partially protected against the pressor action of serotonin when it was subsequently injected. In thinking about these facts one should not forget that dogs, as well as isolated organs, can be protected against the effects of serotonin by serotonin itself (*10, 14*).

Although this possession of both serotoninlike and antiserotonin action may seem perplexing in the extreme, it need not be so. One may picture serotonin as acting on tissues by combination with a receptor specifically designed to react with it. One may also picture these receptors as not all of one kind but varying slightly from tissue to tissue (*15–17*). Serotonin combines with these receptors and, in so doing, causes a contraction of the tissue, just as acetylcholine is believed to do when it combines with its specific receptors (*18*). An antimetabolite such as BAS combines with the serotonin receptors in such a way that serotonin cannot reach them, but still, because the "fit" is not perfect, the BAS does not cause the contraction. It thus blocks the action of serotonin but at the same time does not fulfill the function of the hormone. LSD-25 also because of its structural analogy to the hormone combines with these receptors. From some kinds—for example, those in isolated segments of carotid arteries or in rat uterus—it acts like BAS and blocks the action of serotonin without at the same time causing a serotoninlike contraction. For other kinds of serotonin receptors—for example, those in *V. mercenaria* hearts—the LSD-25 not only combines with the receptors but is able to induce a serotoninlike effect, presumably because the "fit" is good enough. The antiserotonin action of serotonin itself then may be pictured merely as the combination of two or more molecules of serotonin with one receptor site. This site is then blocked because it has not combined with a single molecule of serotonin but rather with several. As was pointed out earlier (*10*), this is the classical picture of inhibition of an enzyme by an excess of its substrate and seems applicable here as well.

Do these findings of a serotoninlike action of LSD-25 mean that we can decide between the alternate explanations of an excess and a deficiency of serotonin in the causation of mental disease as pictured in references 1 and 6? It seems unwarranted to answer this question now. In the first place, the concept does not depend on the hallucinogenic effects of LSD-25 alone but rather on the central actions of a variety of analogs of serotonin—namely, harmine, yohimbine, medmain, and so on. It will be necessary to demonstrate that all of these analogs have serotoninlike activities if the theory of excess is to prevail (*19*). Furthermore, the abnormal (psychotic?) behavior induced in mice by LSD-25 has been prevented by serotonin (*20*). This might argue in favor of the hallucinations being manifestations of deficiency. Nevertheless the antiserotonin action of excess serotonin itself may obscure this conclusion. It would seem that both possibilities (excess and deficiency) must be kept in mind until a more crucial means of testing becomes available.

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References and Notes

1. D. W. Woolley and E. Shaw, *Proc. Natl. Acad. Sci. U.S.* 40, 228 (1954).
2. ———, *Federation Proc.* 12, 293 (1953); E. N. Shaw and D. W. Woolley, *J. Biol. Chem.* 203, 979 (1953).
3. E. Fingl and J. H. Gaddum, *Federation Proc.* 12, 320 (1953).
4. W. A. Stoll, *Schweiz. Arch. Neurol. Psychiat.* 68, 279 (1947).
5. H. H. Benitez, M. R. Murray, D. W. Woolley, *Anat. Record* 121, 466 (1955).
6. D. W. Woolley and E. Shaw, *Brit. Med. J.* 2, 122 (1954).
7. J. H. Welsh, *Federation Proc.* 13, 162 (1954).
8. Kindly supplied by Sandoz Chemical Works, Inc.
9. I. H. Page and J. W. McCubbin, *Circ. Res.* 1, 354 (1953).
10. E. N. Shaw and D. W. Woolley, *J. Pharmacol. Exptl. Therap.* 116, 164 (1956).
11. D. W. Woolley and E. N. Shaw, *Science*, in press.
12. Somewhat more BAS was needed to protect an animal against the pressor effects of LSD-25 than against those of serotonin.
13. A. S. Marrazzi and E. R. Hart, *Science* 121, 365 (1955).
14. J. H. Gaddum, *J. Physiol. London* 119, 363 (1953).
15. This difference is not merely conjectural, because differences in combining activity of the presumed receptors in various tissues have been demonstrated (*10, 16, 17*).
16. E. Shaw and D. W. Woolley, *J. Pharmacol. Exptl. Therap.* 111, 43 (1954).
17. J. H. Gaddum and K. A. Hameed, *Brit. J. Pharmacol.* 9, 24 (1954).
18. D. Nachmansohn, *Harvey Lectures Ser. 49* 57 (1953–54).
19. Here it must not be forgotten that medmain does show slight serotoninlike action on some tissues (*16*) and that, although we have not detected serotoninlike effects of harmine, some enhancement of serotonin action has been observed in dogs and in *V. mercenaria*.
20. D. W. Woolley, *Proc. Natl. Acad. Sci. U.S.* 41, 338 (1955).

* With the technical assistance of E. Van Winkle and M. DeLucia.

26 March 1956

Gamma-ray Activity of Contemporary Man

Measurements of the natural gamma-ray radioactivity of the human body have been reported recently by several workers who made use of large ionization chambers (*1*) or liquid scintillation counters (*2*) surrounding the subject to be investigated. These apparatus, however, do not have adequate spectrometric properties to permit identification of the radioelements involved.

In our laboratory, following successful reduction of the background radiation by shielding and choice of crystal canning material (*3, 4*), we have availed ourselves of a NaI scintillation crystal (10.8 cm in diameter and 3.8 cm thick) mounted on a DuMont 6364 phototube connected to a Marconi 24-channel pulse analyzer (5). Whole body radiation was measured by placing the face of this crystal 8 cm from the back of a seated person at the height of the twelfth thoracic vertebra (*6*). Background readings were obtained with a similarly placed mockup consisting of distilled water in steel cans. As a standard of K^{40} activity, 2 lb of KOH (C.P.) in sealed bottles was used at a distance of 40 cm. Geometric and scattering parameters *in vivo* were determined experimentally by the use of a few microcuries of K^{42}, the gamma ray of which has sensibly the same energy as that of K^{40}. The short-lived isotope solution was divided into two equal parts, one of which was administered to the subject and the other of which was retained as an intermediate radioactive standard after dilution in a mass of water of electron content equivalent to the 2 lb of KOH. Comparisons were made *in vivo* 10 hours or more after ingestion in order to attain equilibrium between K^{42} and K^{40}.

Preliminary pulse-height spectra of the radiation emitted by uncontaminated members of our staff were obtained in early 1955 (*7*). They disclosed potassium as essentially the only radioelement, in amounts corresponding to 0.22 percent of body weight in men and 0.16 percent in women. Inasmuch as this activity represents about 10^{-8} c of gamma radiation,

the activity of Ra, expected in amounts of 0.5×10^{-10} c (*8*), could not be measured in its presence despite the fact that the probable average deviation of a 2-hour reading of background was equivalent to only 4×10^{-11} g of Ra in the body.

Subsequent observations on members of our staff, a few visitors from various parts of the country and from overseas, local medical students, and foreign student members of the reactor school have disclosed the presence of a photopeak around 660 kev (*9*) in the scintillation spectra of all our test subjects (see Fig. 1) and its gradual increase in three individuals who were available for long-term study. No correlation was noted between net photopeak height and geographic origin of the subject. This type of radiation was detected also in various samples of urine, where the presence of the suspected element, Cs^{137}, was confirmed through chemical separation (*10*) of the activity by the addition of carrier to the ashed urine and double precipitations of cesium silicowolframate and perchlorate (*11*). The amounts involved *in vivo* ($\sim 10^{-9}$ c) are several orders of magnitude lower than accepted permissible levels (*12*).

In order to reconcile the persistence of the photopeak with the relatively short biological life of cesium (*13*), a few tests were performed to identify the contaminating sources. Of the foods, some, but not all, of the meats and milk powders were positive, whereas drinking water, vegetables, and sea scallops proved to be negative. Filter-collected dust of laboratory air and sweepings from house carpets from Chicago, Cleveland, and Tucson failed to disclose the Cs^{137} photopeak in the presence of overriding activities at 150, 500, and 750 kev. These energies indicate the presence of other fission products in the atmosphere—namely Ce, Zr-Nb, and Rh-Ru—and their absence from the spectra of human beings and cattle products is suggestive of low retention on the part of the intact mammal. In general, these findings are consistent with the known abundance of fission products of nuclear detonations and with their metabolic properties (*13*). Moreover, they suggest that Cs^{137} might be gaining access into the human body by its continual deposition on grazing lands and following thereafter much the same pathways described in the case of Sr^{90} (*14*).

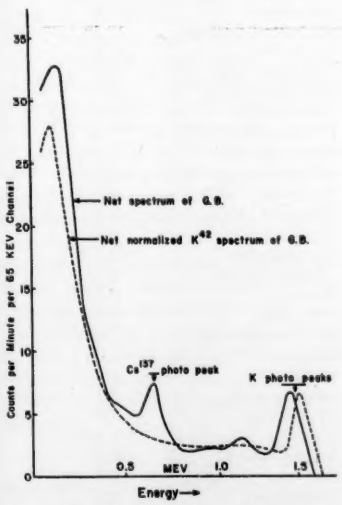

Fig. 1. (Solid curve) Typical scintillation spectrum of a human being (1955). (Dashed curve) Scintillation spectrum of the same individual after administration of K^{42} with its own natural spectrum subtracted. Ordinates are normalized to equal photopeak values.

Despite these difficulties, estimates of total body potassium remained feasible by restricting analysis to the 700-kev-to-1.6 Mev pulse-height band. For 12 male subjects (22 to 34 years old) who were studied, the average amount of potassium as percentage of body weight was 0.188 ± 0.006; for three women (22 to 29 years old), it was 0.154 ± 0.003.

Our figures appear somewhat lower than those based on body activity measurements and in better agreement with those obtained by radioisotope dilution techniques (*15*). Although the averages quoted here possess statistical uncertainties considerably lower than those of previous reports, they cannot be assumed to demonstrate either the existence or absence of nonexchangeable potassium in human beings of the much larger variations in individual potassium content. Clarification of the issue will require application of both techniques to the same subject, with accuracies higher than those reported heretofore (*16*) and with due attention paid to the existence of exogenous contaminants (*17*).

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References and Notes

1. R. M. Sievert, *Arkiv Fysik* 3, 337 (1951); F. W. Spiers and P. R. J. Burch, *Biological Hazards of Atomic Energy* (Oxford Univ. Press, London, 1952), p. 203; J. Rundo, *J. Sci. Instr.* 32, 379 (1955).
2. E. C. Anderson *et al.*, *Nucleonics* 14, No. 1, 26 (1956).
3. C. E. Miller *et al.*, *Trans. I.R.E. Profess. Group on Nuclear Sci.*, in press; *Nucleonics*, in press; *Argonne Natl. Lab. Rept. No. 5456* (1955), p. 107.
4. We wish to thank J. E. Rose and R. E. Rowland for their contribution to the development of the low level counting facility; also O. J. Steingraber for his technical assistance.
5. Work performed under the auspices of the U.S. Atomic Energy Commission.
6. L. D. Marinelli *et al.*, *Am. J. Roentgenol. Radium Therapy Nuclear Med.* 73, 661 (1955).
7. C. E. Miller and L. D. Marinelli, *Argonne Natl. Lab. Rept. No. 5456* (1955), p. 120.
8. J. B. Hursh and A. A. Gates, *Nucleonics* 7, No. 1, 46 (1950); A. F. Stehney and H. F. Lucas, Jr., "Studies on the radium content of humans arising from the natural radium of their environment," Paper A/CONF.8/P/852, *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy* (United Nations, New York, 1956), vol. 11, p. 49.
9. C. E. Miller and L. D. Marinelli, *Radiology* 66, 104 (1956); *Argonne Natl. Lab. Rept. No. 5518* (1956), p. 52.
10. We are deeply indebted to Jacob Sedlet for the cesium separation.
11. L. E. Glendenin and C. M. Nelson, National Nuclear Energy Series, Div. IV, vol. 9, *Radiochemical Studies: The Fission Products Book 3* (McGraw-Hill, New York, 1951), p. 1642.
12. "Maximum permissible amounts of radioisotopes in the human body and maximum permissible concentrations in air and water, *Natl. Bur. Standards U.S. Handbook* No. 52 (Government Printing Office, Washington, D.C., 1953).
13. ORO-77 (1952); Also J. G. Hamilton, *Radiology* 49, 325 (1947).
14. W. F. Libby, *Science* 123, 657 (1956), *U.S. Atomic Energy Commission 19th Semiannual Rept.* (Government Printing Office, Washington, D.C., January 1956), p. 72.
15. R. M. Sievert, "Measurements of low level radioactivity, particularly the gamma-radiation from living subjects," Paper A/CONF.-8/P/792. *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy* (United Nations, New York, 1956), vol. 13, p. 187.
16. J. Rundo and U. Sagild, *Nature* 175, 774 (1955).
17. A detailed report of this investigation is in preparation.

27 March 1956

Mitochondrial Self-Duplication Observed in vitro

Two mechanisms of genesis of mitochondria have been suggested. Lindberg and Ernster (*1*) have concluded that the microsomal fraction of cytoplasm is gradually and continually converted into mitochondria by retention of synthesized protein. On the other hand, Ephrussi (*2*) and others advocate cytoplasmic genetic continuity, thus requiring autoduplication of these cytoplasmic elements. Such a process was reported for mitochondria in 1910 by Faure-Fremiet (*3*). In the course of some studies we performed on the morphology of mitochondria, this phenomenon of self-duplication was also found to occur *in vitro*.

In these experiments (*4*) mitochondria from fasted rat liver were used (Long-Evans, 200 g). They were prepared and examined in either 0.25*M* or 0.60*M* sucrose (*5*).

The mitochondria in the "fluffy layer," which is usually discarded, was found to contain a high percentage of limbus or club forms (*6*). Examination with the phase microscope (× 1455) at room temperature showed that many of this type had a slight constriction in the transverse plane. The larger rod forms found in the fluffy layer were also similarly constricted. If these types were watched over a period of time, they were seen to constrict actively, thus eventually forming two fragments. At least one of these

fragments was able to form the typical "crescent" which is a degenerating form of normal mitochondria (*6*). Those observed in 0.6*M* sucrose retained normal morphology for a longer period. The time for the complete process varied from 15 to 35 minutes. The actual division took about 8 minutes.

In general it was noted that there was a gradation of response to the unnatural *in vitro* conditions which appeared to be correlated with the size of the mitochondria. The larger mitochondria formed crescents of a large size in extremely short intervals, whereas the smallest freshly isolated ones took somewhere between 5 and 20 hours to form typical but diminutive crescents. It would appear therefore that this group of small mitochondria were newly formed by unequal division of larger mitochondria and had not yet elaborated intramitochondrial protein.

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References and Notes

1. O. Lindberg and L. Ernster, *Protoplasma* III, A4, 114 (1954).
2. B. Ephrussi. *Nucleo-cytoplasmic Relationships in Micro-organisms.* (Clarendon, Oxford, 1953).
3. E. Faure-Fremiet, *Anat. Anz.* **36**, 186 (1910).
4. This work was carried out under grant No. C-2303 from the U.S. Public Health Service.
5. P. E. Kennedy and A. L. Lehnenger, *J. Biol. Chem.* **179**, 957 (1949).
6. J. W. Harrnan *et al.*, *Exptl. Cell Research* **3**, 509 (1952).

26 March 1956

Dual Requirement of Walker Carcinosarcoma 256 in vitro for Asparagine and Glutamine

A routine procedure for the cultivation of the Walker carcinosarcoma 256 in tissue culture recently was developed in this laboratory (*1*). The technique involved the use of cell suspensions, which were prepared from the freshly excised tumor, as the initial inoculum. The medium consisted of 5-percent rat or horse serum, an amino acid and vitamin mixture, and 0.05-percent Bacto yeast extract with Earle's balanced salt solution (*2*) as the diluting fluid. Both serum and yeast extract were essential for satisfactory growth. The cells adhered to the surface of T-15 flasks and increased several fold within 72 to 96 hours.

Although the medium was adequate for good growth of the Walker tumor, the available amino acids and other factors in the serum and yeast extract precluded the determination of specific nutritive requirements of the Walker tumor *in vitro*. Thus, further simplification of the medium was desirable. The present report describes a simplified medium that permits the study of essential components for the Walker tumor. Furthermore, a dual requirement of the tumor for asparagine and glutamine is demonstrated.

Initial studies consisted of observing the growth-promoting activity of yeast extract after it had undergone treatments or fractionation. The activity was lost upon autoclaving in 2*N* HCl for 1 hour at 15 lb pressure but was retained upon autoclaving in a simple aqueous solution. Decolorizing a solution of yeast extract with Nuchar would not remove the activity, but the active portion was adsorbed on columns of IRA 400 (hydroxyl form) or on Dowex 50 (hydrogen form). Thus, the growth factors appeared to be amphoteric in nature and labile under acid conditions of hydrolysis.

An active fraction was isolated from the Dowex-50 column by elution with 1.5*N* HCl in a chromatographic procedure similar to that of Stein and Moore (*3*). This fraction was found to contain asparagine, by chromatography on paper buffered at *p*H 6.2 according to the procedure of McFarren (*4*). Upon replacement of yeast extract with 0.05–10m*M* L-asparagine (*5*), the cells proliferated as rapidly in 72-hour test periods as they had previously on whole-yeast extract. Without L-asparagine or yeast extract, the cells did not survive. D-Asparagine (*5*), was inactive, although it did not inhibit growth appreciably when it was added at 20m*M* in the presence of 1.5m*M* L-asparagine.

Following this work, the use of dialyzed serum was studied. Human serum was dialyzed for 24 hours at 4°C in a slow-moving shaker against 100 vol of Earle's solution. This preparation adequately replaced the requirement of whole serum, whether rat, horse, or human. The vitamin complement of the medium was altered to insure fortification for prolonged growth. The composition of this new simplified medium (herein referred to as medium 2) is shown in Table 1. Medium 2 was found to support subcultures indefinitely.

The biological and chemical similarity of glutamine to asparagine, as well as the essentiality of glutamine to other mammalian cells in tissue culture (*6, 7*), prompted the investigation of the glutamine in addition to the asparagine requirement of the Walker-256 cells. The cultures were established as was previously described (*1*) and grown for 48 hours in 2 ml of medium, which was then replaced by 3 ml of fresh medium. Growth was determined by whole-cell counts in a hemocytometer with an overall accuracy of ± 10 percent.

The response of the Walker-tumor cells to aspartic acid and glutamic acid and their amides is shown in Table 2. One can observe the nonessential nature of L-aspartic acid and L-glutamic acid to the Walker cells. L-Aspartic acid in higher concentrations did not appear to be exceptionally toxic. However, L-glutamic acid exhibited a striking toxicity to the cells in concentrations above 2m*M*. This is in contrast with the nontoxicity of L-glutamic acid reported for other mammalian cells under tissue-culture conditions (*7*).

Evidently, the Walker-256 cells have a dual requirement for asparagine and glutamine, since the cells failed to become established and died rapidly upon omission of either compound from the medium. It was also interesting to note that the requirement for glutamine was several times as great as the requirement

Table 1. Composition of medium 2.

Component	Concentration of final medium (μg/ml)	Percent
DL-Tryptophan	6.1	
DL-Phenylalanine	24.8	
L-Tyrosine	8.2	
L-Arginine · HCl	15.8	
L-Histidine · HCl · H_2O	6.3	
L-Lysine · HCl	27.4	
L-Cysteine · HCl · H_2O	7.9	
DL-Methionine	13.4	
L-Isoleucine	18.8	
L-Leucine	18.8	
DL-Valine	35.2	
DL-Threonine	35.7	
Glycine	11.3	
DL-Alanine	27.7	
L-Proline	16.8	
Hydroxy-L-proline	18.1	
DL-Serine	31.8	
L-Aspartic acid	20.0	
L-Glutamic acid	22.1	
L-Glutamine	219.2	
L-Asparagine · H_2O	30.0	
Thiamine · HCl	0.2	
Riboflavin	0.2	
Pyridoxine · HCl	0.5	
Pyridoxal · HCl	0.5	
Nicotinic acid	0.5	
Nicotinamide	0.5	
Ca pantethenate	0.2	
Biotin	0.2	
Folic acid	0.2	
Choline chloride	5.0	
Inositol	1.0	
PABA	1.0	
Ascorbic acid	0.5	
Glutathione	0.5	
B_{12}	7.5×10^{-5}	
Na penicillin G	50.0	
Streptomycin sulfate	50.0	
Phenol red	2.5	
NaCl		0.65
KCl		0.04
$MgSO_4 \cdot 7H_2O$		0.02
$NaH_2PO_4 \cdot H_2O$		0.014
$NaHCO_3$		0.22
Glucose		0.30
Dialyzed human serum		5.0

Table 2. The response of Walker carcinosarcoma 256 to aspartic acid, glutamic acid, and their amides.*

Concentration in final medium	Response (cells × 10^{-3}/ml)†			
	L-Aspartic acid	L-Glutamic acid	L-Asparagine	L-Glutamine
(m*M*)				
0	626	538	25	18
0.01			56	
0.02			241	
0.05	572	518	996	
0.1	696	522	1013	80
0.2	476	480	1032	212
0.5			1038	632
1.0	603	396	990	976
1.5				830
2	664	351	879	905
3				659
5	559	128	828	504
10	667	53	779	376
20	464	20	638	312

* Cells were grown 72 hours in basal medium described containing the single amino acid or amide in the concentration indicated. Medium was renewed at 48 hours. The initial inoculum was 200,000 cells per milliliter.
† Corrected to compare with initial volume.

for asparagine. The optimal concentration of L-glutamine appeared to be approximately 1.5m*M*, while the optimal concentration of L-asparagine was approximately 0.2 m*M*. These observations were confirmed using cells that had become established in the complete medium and were then exposed to a deficient medium. When the concentration of L-glutamine or L-asparagine was in excess of 10m*M*, a moderate inhibiting effect was observed.

In attempts to replace the asparagine and glutamine requirement, neither L-aspartic acid nor L-glutamic acid, with or without ammonium chloride and ATP, were able to replace the requirement for its corresponding amide. Massive quantities of glutamine were incapable of replacing the requirement for asparagine, nor could asparagine replace the requirement for glutamine. The specific requirement for both asparagine and glutamine by the Walker tumor is particularly interesting, since we have been unable to find evidence of a living system, mammalian or microbiological, which requires both of these amides and exhibits no requirement for the corresponding amino acids (*8*).

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References and Notes

1. T. A. McCoy and R. E. Neuman, *J. Natl. Cancer Inst.* 16, 1221 (1956).
2. R. C. Parker, *Methods in Tissue Culture* (Hoeber, New York, ed. 2, 1950), p. 80.
3. W. H. Stein and S. Moore, *Cold Spring Harbor Symposia Quant. Biol.* 14, 179 (1949).
4. E. F. McFarren, *Anal. Chem.* 23, 168 (1951).
5. H. M. Chemical Co., Santa Monica, Calif.
6. H. Eagle, *Science* 122, 501 (1955).
7. ——— *et al.*, *J. Biol. Chem.* 218, 607 (1956).
8. We gratefully acknowledge the technical assistance of Jane Avery, Merle D. Maxwell, and Eugene Conway.

6 April 1956

Induced Biosynthesis of Uricase in Yeast

Uric acid is assimilated by *Torulopsis utilis* (*1*), and the presence of uricase in adenine-adapted yeast has been noted (*2*). This report (*3*) deals with the uptake of uric acid by *T. utilis* cells and the subsequent increase in the uricase activity of cellular extracts.

Torulopsis utilis (ATCC 9950) was grown with aeration in the medium described previously (*2*); the cells were collected by centrifugation, washed with distilled water, and stored at 4°C until used. To increase the uricase content of the yeast, 1 g (wet wt.) of the yeast was aerated in 100 ml of medium of the same composition except that the nitrogen source was 0.1 mg/ml of uric acid. The decreasing uric acid content of the medium was followed by measurement of the optical density of a 1/10 dilution of the medium at 293 mμ after removal of the cells by centrifugation. To estimate the intracellular uric acid content, the sedimented yeast cells were suspended in 10 ml of distilled water and heated in a boiling-water bath for 10 minutes; the optical density of the extract that was obtained upon centrifugation was measured at 293 mμ. Uricase activities were measured by the method of Kalckar (*4*) on yeast extracts in *p*H 9.5 borate buffer obtained with the aid of a Hughes press (*5*) operated at dry-ice temperature. Protein was determined by the method of Lowry *et al.* (*6*) with bovine plasma albumin as the standard.

Results of typical experiments are illustrated in Fig. 1. There is a time lag of about 1 hour before the uric acid starts to disappear from the medium at a high rate (curve *A*). The disappearance of the uric acid from the medium is accompanied by the intracellular accumulation of uric acid (curve *B*); analyses of the cellular extracts with uricase show that the absorbing compound is uric acid. An estimate based on the cell count, cell volume, optical density of the medium, and optical density of the cellular extract indicated that upon completion of the removal of uric acid from the medium, the concentration of uric acid within the yeast cell is about 600 times the original concentration in the medium. The specific activity of the yeast uricase increases only after the rapid accumulation of uric acid by the yeast cell starts (curve *C*). The lag period prior to the rapid uptake of uric acid is abolished by aeration of the yeast in the medium for 2 hours prior to the addition of uric acid, the nitrogen source (curve *A'*). There is no uptake of uric acid in the absence of glucose, and anaerobic conditions do not prevent the uptake with glucose in the medium.

The effect of various inhibitors on the uptake of uric acid by the yeast cell was investigated. Potassium cyanide (0.038*M*), an inhibitor of uricase (*7*), completely stopped the uptake under all conditions. Sodium arsenate ($10^{-3}M$) inhibited the uptake if it was present during a 2-hour aeration period prior to the addition of uric acid but not if it was added with the uric acid after preaeration; if the yeast cells that have been exposed to arsenate for 2 hours are removed from the medium by centrifugation, washed, and resuspended in fresh medium without the inhibitor, uptake occurs upon the addition of uric acid. The inhibition of uptake by $10^{-3}M$ arsenate is prevented if 0.02*M* phosphate is present with the arsenate during the experiment.

A consideration of these results has led to the following tentative conclusions and working hypotheses. (i) In the system described, when there was a lag period in the induced synthesis of uricase, the lag is dependent on the penetration of the cell wall by the substrate. (ii) The accumulation of uric acid by the cell involves active transport (*8*). (iii) Glucose metabolism, accompanied by the

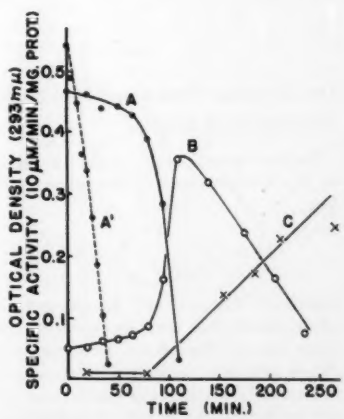

Fig. 1. The intracellular accumulation of uric acid by *T. utilis* and the resulting formation of uricase. (*A*) Optical density of the uric acid medium, yeast added at zero time; (*B*) optical density of the corresponding extracts of boiled yeast; (*C*) specific activity (uricase) of the corresponding extracts of frozen yeast; (*A'*) optical density of the uric acid medium, yeast aerated for 2 hours prior to the addition of uric acid to the medium at zero time.

formation of energy-rich phosphate bonds, probably at the glyceraldehyde-3-phosphate dehydrogenase step only, is required for the uptake of uric acid. This is consistent with the known action of arsenate (*9*) on glucose metabolism. (iv) After the maximal accumulation of uric acid by the yeast cell, the uricase activity of the cell increases at a constant rate until all of the uric acid is metabolized. (v) After the maximal accumulation of uric acid by the yeast cell, the uric acid is metabolized at a constant rate.

The properties of the yeast uricase are being investigated and compared with animal uricase. A detailed study of the uptake of uric acid by the yeast cell is in progress in these laboratories.

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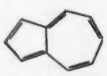
References and Notes

1. F. J. Di Carlo, A. S. Schultz, D. K. McManus, *J. Biol. Chem.* **189**, 151 (1951).
2. A. H. Roush, *Arch. Biochem. and Biophys.* **50**, 510 (1954).
3. This investigation was supported by research grant C-2510 from the National Cancer Institute, U.S. Public Health Service.
4. H. M. Kalckar, *J. Biol. Chem.* **167**, 461 (1947).
5. D. E. Hughes, *Brit. J. Exptl. Pathol.* **32**, 97 (1951).
6. O. H. Lowry *et al.*, *J. Biol. Chem.* **193**, 265 (1951).
7. H. R. Mahler, G. Hübscher, H. Baum, *ibid.* **216**, 625 (1955).
8. H. T. Ussing, in *Ion Transport across Membranes*, H. T. Clarke, Ed. (Academic, New York, 1954).
9. O. Warburg and W. Christian, *Biochem Z.* **303**, 40 (1939).

26 March 1956

On the Space Group and Molecular Orientation of Azulene

In their investigation of the structure of the nonbenzenoid hydrocarbon azulene,



Günthard, Plattner, and Brandenberger (*1*) reported that the x-ray space group extinctions of the crystal correspond to $P2_1/a$, and that the unit cell contains 2 molecules. This requires positioning of the molecules on centers of symmetry, which is possible only if disorder is present. Günthard (*2*) was unable to solve the structure in this space group.

We have reexamined the structure (*3*). Lattice constants of the monoclinic crystal are $a = 7.89 \pm 0.03$ A, $b = 6.06 \pm 0.03$ A, $c = 7.94 \pm 0.03$ A, $\beta = 103° \pm 0.5°$, $a:b:c = 1.301:1:1.130$. We also find x-ray extinctions which would lead one to assign $P2_1/a$ as space group. The calculated specific gravity of 1.165 compares well with the measured value of 1.17. There are indeed 2 molecules per cell. A test for piezoelectricity was negative.

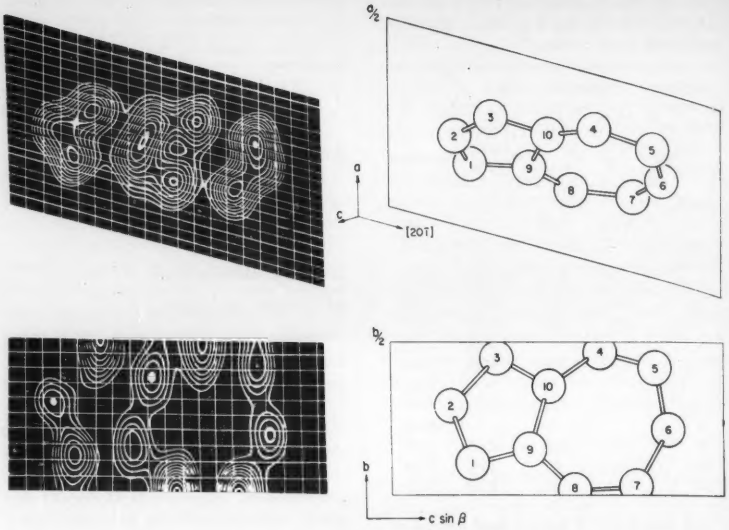


Fig. 1. Fourier projections of azulene on (010) and (100) planes and corresponding projections of molecule.

There is no evidence of disorder in any layer lines of the Weissenberg patterns. If random orientation of the molecules is present, it is thus on a molecular level; that is, there are no small ordered regions, of the nature of twin domains. Since the dipole strength of azulene is high, such a random arrangement is unlikely; that is, one would at least expect to find small ordered domains. We have examined the possibility of the random arrangement in $P2_1/a$ crystallographically; and we have compared this possibility with consequences of the assumption of a space group of lower symmetry—either $P2_1$ or Pa, with the extinctions which suggest a screw-axis along b owing to a pseudo translational symmetry in that direction. In the case of the lower symmetries, we have assumed that piezoelectricity is unobservable owing to weak electromechanical coupling.

$P2_1$ can be excluded because the glide a cannot be included as a pseudo-symmetry. Pa is a distinct possibility. If the projection of molecules on the b-axis is symmetrical about a point lying halfway between the glide planes, $(0k0)$ reflections will appear only if k is even; this would then explain the extinctions that led one to expect a twofold screw-axis. Taking the glide planes at $(x,0,z)$ and $(x,1/2,z)$, the polar axis of azulene will be on or very close to $(x,1/4,z)$ when adjoining molecules are at most reasonable distances.

Intensity data were obtained by the multiple-film technique using *CoK*α radiation ($\lambda = 1.79$A). The approximate orientation of the molecule on the (010) plane was derived from a weighted reciprocal lattice $(h0l)$, in which strong reflections were observed in a distorted hexagonal arrangement. The vector transform of the projected molecule thus derived was in good agreement with the peaks of a sharpened Patterson, computed using $F^2(h0l)/\Sigma f_i^2$ as coefficients. Since glide a is the only symmetry element, the molecule could be located at any place in the asymmetric unit of the (010) projection. For the phase calculation, the center of the polar axis of the molecule was located at (0,1/2). The real part of the structure factor for Pa then corresponds to the *entire* factor for the case of a disordered structure in $P2_1/a$; and it thus is a simple matter to compare possible structures in Pa and $P2_1/a$.

Symmetry Pa was fully supported by successive S-FAC and X-RAC calculations, which resulted in a well-defined Fourier projection $\rho(x,z)$. The R-factor was reduced to less than 20 percent for $F(h0l)$ in Pa. The R-factor for the already unlikely case of a random structure in $P2_1/a$ could not be reduced below 24 percent. Fourier projections $\rho(x,z)$ and $\rho(y,z)$ are shown in Fig. 1. Atomic coordinates derived from these are given in Table 1.

The y parameters result in no observable intensities for odd-order $(0k0)$ spectra. The latter parameters are not yet determined with sufficient accuracy, owing to overlapping in the (100) projection, to justify reporting of interatomic distances. At this stage of the analysis the molecule appears to be planar, with the plane inclined about 63°

Table 1. Atomic coordinates for azulene.

Atom	x/a	y/b	z/c
C_1	0.033_5	0.09	0.760
C_2	0.134_5	0.29	0.819
C_3	0.153	0.45	0.700
C_4	0.039	0.47	0.387
C_5	−0.060	0.41	0.212
C_6	−0.136	0.21	0.186
C_7	-0.171_5	0.03	0.281
C_8	−0.106	0.02	0.462
C_9	-0.009_5	0.15	0.581
C_{10}	0.060	0.35	0.530

to the (010) plane. The general scheme of the crystal structure is similar to that of naphthalene (*4*). The shortest distance between atoms in neighboring molecules is 3.6_1 A. Details of the molecular configuration require a three-dimensional analysis. This is in progress.

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References and Notes

1. H. Günthard, Pl. A. Plattner, E. Brandenberger, *Structure Reports* **11**, 713 (1948).
2. H. Günthard, *ibid.* **13**, 562 (1950).
3. This analysis is supported by grant A-228 from the National Institutes of Health. X-RAC and S-FAC calculations are supported by contract No. N6-onr-269, T. O. 16 with the Office of Naval Research. We are indebted to Pl. A. Plattner of Hoffman-La Roche in Basel for introducing us to the problem and furnishing crystalline material, to V. Vand for helpful discussions, and to Mrs. J. W. Turley for IBM computation of structure factors.
4. J. M. Robertson, *Proc. Roy. Soc.* (*London*) *A* **140**, 79 (1933) and **142**, 674 (1933).

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9 February 1956

International Relations in Science and Problems of Visas

In this brief report I wish to relate factually the events of the failure to bring to the United States a distinguished French astronomer for a conference 3–5 April 1956 that was sponsored by the National Science Foundation and the Leander McCormick Observatory of the University of Virginia.

On 3 May 1955, the steering committee of the conference drew up a list of twenty specialists in the field of cosmic distance determination. Daniel Chalonge of the Institut d'Astrophysique, Paris, France, eminently qualified in this field, was included in the list. Since Chalonge on a previous occasion had had difficulties in obtaining a visa, it was thought advisable to make inquiries with the State Department before inviting him. This was done through the Office of the Division of International Relations of the National Academy–National Research Council, the channel through which scientists handle matters of this type. In a letter dated 21 June 1955 to the division, I stated, "Before inviting Dr. Chalonge to take part in this conference I am anxious to learn the attitude of the State Department in view of the past history of the case. I do not wish to embarass him, our government nor ourselves. I understand the difficulties of the situation. We may be told that the case cannot be considered until he applies for a visa but I am afraid this will not solve the problem." The letter also included a long paragraph relating to the history of the previous failure as far as known to me. Early in August 1955, while I was in Oslo attending a meeting of the International Council of Scientific Unions, I was informed verbally by a member of the staff of the Science Advisor to the State Department, and in the presence of the other members of the American delegation, that on the basis of information he had received, I should proceed to invite Chalonge. With this assurance we extended the invitation late in August 1955, during the meeting of the International Astronomical Union in Dublin, Ireland.

I know that Chalonge spent much time during the succeeding months preparing for his visit to the United States, which was to include colloquium lectures at eight astronomical centers in the eastern United States following the Virginia conference. I understand that Madame Chalonge visited the U.S. Consulate in December 1955 and that she was informed that they had plenty of time for application for the visa. In January 1956 they applied and planned to sail on 22 March. Since by the middle of February they had received no reply, I wrote to the office of the Science Advisor on 22 February. The reply stated "Apparently Dr. Chalonge applied for his visa only recently. If he had followed the suggestion that I passed along to you, and you to him, last August of applying for his visa promptly, he probably would not have had any current worries." Here some misunderstanding must have occurred, for I do not recall being instructed of "prompt application," and the Paris Consulate did not indicate its need. On 2 March, I telephoned the Office of International Relations of the Academy and after they had consulted the State Department, they informed me that there were no complications and that the visa would be issued. On 12 March I telephoned again and I was told that the matter was being taken up with the Attorney General and that it would take a week or at the most 10 days for processing the case but I could rest assured that the action would be favorable. I advised Chalonge accordingly and suggested that he change the time of his departure to 29 March which I knew beforehand it was possible to do.

On the evening of 28 March, the day before his planned sailing, the U.S. Consulate informed him that since he is a member of the French-USSR Cultural Society, which under the American law is considered a communistic group, his visa could not be issued for more than three days, the duration of the conference. Under these conditions Chalonge refused the visa and wrote as follows.

"Dans ces conditions, je n'ai pas cru pouvoir accepter le visa car il était un peu humiliant pour moi d'être ainsi sous le contrôle de la police, comme un malfaiteur.

"J'ai pris cette décision avec beaucoup de peine en pensant aux efforts qu'ont fait mes amis américains pour me faire venir."

It is unfortunate that Chalonge felt that his limited visa implied police control. To be notified only at the very last moment of departure and be told that he is permitted to stay in the United States for 3 days only seems most unreasonable.

All this is, of course, regrettable for all parties concerned, including the State Department and the Attorney General's office.

In conclusion, I wish to emphasize that the aim of this report is to give all the facts as I know them with the hope that they might contribute in remedying a situation which is detrimental to science and our international relations.

Last August at the International Astronomical Union Meeting in Dublin, the American Delegation was authorized to extend, on behalf of the U.S. Government, an invitation to the union to hold its 1961 General Assembly in the United States. If such a meeting takes place, some 400 foreign astronomers may be coming. It seems obvious that under existing conditions careful consideration of this problem is needed, and before our General Assembly in 1958.

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22 June 1956

Neoplastic Changes Developing in Epithelial Cell Lines Derived from Normal Persons

That animal fibroblasts grown continuously in tissue culture can develop the ability to produce tumors considered histopathologically as sarcomas has been demonstrated on numerous occasions (*1*). The present report concerns the acquisition of a similar ability by four strains of human epithelial cells which

have been developed by R. S. Chang (*2*) from normal liver, kidney, and conjunctiva. Two of the cell lines, liver and conjunctiva, had been carried in our laboratory in a medium containing bovine amniotic fluid and human serum, and two, kidney and conjunctiva, had been carried in the laboratories of Coriell and McAllister at the South Jersey Medical Research Foundation in Eagle's synthetic medium to which horse serum had been added. The latter two cell lines were used only for implantation experiments in irradiated and cortisone-treated rats and human volunteers.

Our reasons for stating that the liver, kidney, and conjunctiva cell lines, after more than 50 passages in tissue culture, have developed characteristics which are commonly associated with neoplasia (here defined as the ability to produce a new growth) are as follows.

1) *Cytological observations.* Stained preparations when compared with the thirteenth passage from Chang, which he kindly provided to us, showed the following differences. The pavementlike characteristic arrangement of epithelium was disrupted, and although the cells continued to grow in sheets, the cell edges were less closely approximated. The cells varied in size and shape, the nuclei were often large, and the cytoplasm stained unevenly. There was great variety in the size, shape, and number of nucleoli, which were often drawn out into odd shapes. The centrosome, which was evident in our cell lines, seemed more prominent in the conjunctival cultures where it often indented the nucleus. There were occasional multinucleated cells and tripolar mitoses (Fig. 1) (*3*).

2) *Chromosome studies.* Examination of the chromosomes by Albert Levan of the Institute of Genetics, Lund, Sweden, revealed unequivocal abnormalities. Although tissue-culture preparations of normal adult human fibroblasts from our laboratory showed the usual 48 chromosomes and the idiogram was similar to one described by Hsu (*4*) for human cells (presumably fibroblasts), the findings in the conjunctiva and liver lines were quite different. Both had high chromosome numbers (72 to 80), and the majority of the cells were hypertriploid and had idiograms which differed from the normal in the distribution of chromosome types.

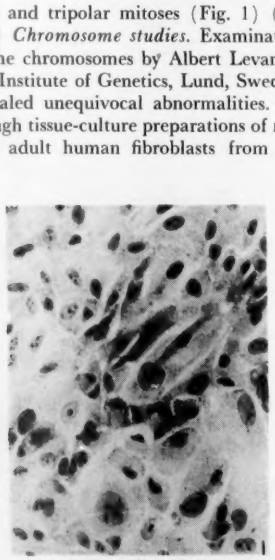

Fig. 1. Tissue culture preparation from the 62nd passage of liver cells (Chang). May-Grünwald stain. × 100.

3) *Inoculation into prepared rats.* It has been amply proved by immunological, chromosomal, and human implantation experiments that it is possible to grow human tissues, both tumors and embryonic tissues, in irradiated and cortisone-treated weanling rats. When 1 to 5 million cells of either the liver, conjunctiva, or kidney (including the strains from Coriell and McAllister's laboratory) were inoculated subcutaneously into the prepared rats, nodules became palpable in 1 week and continued to increase in size until removed for histological sections 2 weeks after implantation. Tumors diagnosed microscopically as malignant appeared in 12 of the 19 animals inoculated. In two instances, the tumor cells were regrown in tissue culture and studies of the chromosomes verified their human origin. Cells inoculated into comparable nonirradiated, untreated rats showed only reaction tissue. Human adult fibroblasts grown in tissue culture from many different types of tissue, both cancerous and normal, did not produce tumors when they were inoculated into prepared rats on 24 different occasions. Human embryonic fibroblasts inoculated three times similarly failed to produce tumors.

4) *Human implantation.* One to 5 million cells of all four cell lines have been implanted subcutaneously into the forearm of volunteers with far advanced cancer. In all there was an immediate transient erythema and swelling due to associated trauma which disappeared the following day. In eight of 11 implantations, a nodule became palpable in 7 days and was removed for section in 9 to 14 days. Two individuals who developed tumors in one forearm failed to develop a tumor in the opposite forearm which had been implanted with 1.5 million human embryonic fibroblasts. There have been no regrowths at the implantation site following excisional biopsy. In each instance, an equal number of similar cells was inoculated into prepared weanling rats and a similar result was produced.

5) *Histopathological diagnosis.* The tumors (Fig. 2) which arose in the treated rats and human beings are described as follows. Examination of the cells grown in rat and man revealed no specific histologic features which would enable one to distinguish the conjunctival from the hepatic cells or to determine the origin of either of these cell types. Furthermore, the patterns of growth in the rat and in man were essentially the same. The cells, whether conjunctival or hepatic, were generally rounded and uniform in appearance. Relatively slight variations in size and shape of nuclei were observed. However, the hyperchromatism and the irregular coarse chromatin distribution was of the type one associates with cancer cells. The cells were distributed haphazardly in the subcutaneous fibrous tissue and fat, in clumps and small sheets, or occasionally in rows. Inflammatory cells, which were sometimes noted, could easily be distinguished from the transplanted cells. The pattern of growth sometimes resembled that of human reticulum cell sarcoma. In areas where there were moderate amounts of fibrous tissue surrounding the cells, the pattern was strongly reminiscent of human breast cancer which has metastasized to skin.

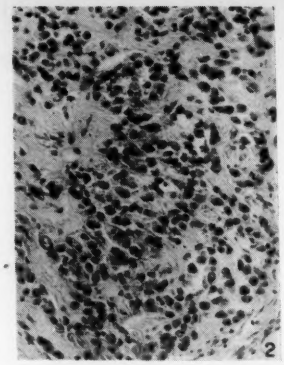

Fig. 2. Neoplasm which formed 9 days after the subcutaneous implantation into a human volunteer of liver cells transferred in tissue culture 63 times. Hematoxylin and eosin stain. × 90.

It must be emphasized that the changes enumerated here have not proved that these cells produce cancer in the clinical sense. It is not known whether they would continue to grow, whether metastasis would occur, or, indeed, whether they would grow in normal human beings. Our basis for saying that the cells are no longer normal rests on their ability to produce tumors in specially treated rats and in human beings, which, when examined microscopically, have the appearance of malignant tumors.

Addendum. Since the preparation of this report, other investigators have noted difficulty in distinguishing "normal" cell liver (Chang) from "tumor" cell lines. Fennell has noted no difference between them when they were examined by the exfoliative cytological technique used clinically, and Leighton, Kline *et al.* have pointed out that

Chang's conjunctiva and Henle's intestine 407, both derived from normal individuals, are indistinguishable cytologically from known tumor cell lines (*5*).

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References and Notes

1. K. K. Sanford, G. D. Likely, W. R. Earle, *J. Natl. Cancer Inst.* **15**, 215 (1954); G. O. Gey *et al.*, *Acta Unio Intern. contra Cancrum* **6**, 706 (1948).
2. R. S. Chang, *Proc. Soc. Exptl Biol. Med.* **87**, 440 (1954).
3. We wish to thank John Biesele for his help in analyzing the cytological picture.
4. T. C. Hsu, *J. Heredity* **43**, 167 (1952).
5. These findings were presented by the authors named at the Tissue Culture Association Conference in Milwaukee, Wis., 3–4 Apr. 1956. Abstracts of the papers can be found in *Anat. Record* **124**, No. 2 (Feb. 1956).

15 March 1956

X-ray Microscopy of Veins of the Skull

The projection x-ray microscope at the University of Redlands is being successfully applied to the study of the distribution and communications of the veins of the diploë in the dog, an x-ray micrograph of which is shown in Fig. 1.

This type of x-ray microscope uses a point source of x-rays less than 1 μ in diameter to cast an enlarged shadow image on a photographic plate. The small source of x-rays is produced by focusing a beam of electrons with two magnetic lenses so that the point source of electrons strikes a window target in the vacuum wall of the x-ray tube. The specimen is kept at atmospheric pressure and yet can be placed within a few microns of the source of x-rays, so that high x-ray magnification can be obtained with the photographic plate or fluorescent screen only a few millimeters away.

The penetrating power of x-rays produces contrast in the image from internal detail of thick specimens, both from natural density differences and from injected radio-opaque material. In addition, the shadow-projection method of x-ray image formation produces an image of all planes of the specimen in focus at once. This makes possible stereoscopic views of the internal detail of a specimen, whereby the orientation within the object is shown in a three-dimensional relationship. A recent review article on x-ray microscopy compares all methods used and lists 102 references to the literature on the subject (*1*). Specific details of design and operation of x-ray microscopes can be found therein.

The veins of the diploë are difficult to expose and to visualize by the usual methods of serial sectioning and graphic reconstruction. Projection x-ray microscopy (*2*) that has been recently developed by Nixon and Cosslett (*3*) over comes many of these difficulties.

To prepare the skull of each dog for study after the animals were sacrificed, the head was perfused through the carotid arteries with physiologic saline to flush the blood from all blood vessels. This was followed by perfusion with red vinyl plastic. To prevent confusion in observing arterioles and venuoles, blue vinyl plastic was injected into the veins by way of the external jugulars. The soft tissues were cut away from the skull, and the floor of the skull was opened to allow for removal of the brain. This procedure allowed the dura mater to remain intact and adherent to the brain case.

Fixation of the skull was achieved by placing it in 10-percent formalin. The skull was mapped into parts and cut, each part being about 1 in.^{2} The skull parts were decalcified by using 5-percent nitric acid and were dehydrated by being passed through 15-percent, 40-percent, and 75-percent isopropyl alcohol solutions. The parts were kept in 75-percent isopropyl alcohol until they were x-ray photographed.

Figure 1 shows the plastic-filled veins of the diploë of the dog in longitudinal parallel formation as they lie between the inner and outer tables of the skull. The x-ray micrograph demonstrates the communications of the smaller diploic veins as branches of the large diploic vein at the top of the micrograph as they approach the center of the skull and connect with the superior sagittal sinus of the dura mater (not shown). In the background, trabeculae, which make up the porous structure of the diploë, appear as light lines, whereas spaces caused by osteoclastic activity are dark.

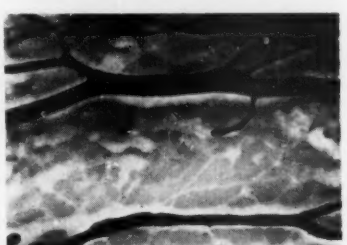

Fig. 1. X-ray micrograph showing diploic veins of the dog skull. Five-minute exposure on Eastman lantern plate contrast emulsion; 12-kv, 25-μa beam current; University of Redlands x-ray microscope (×3.5).

The normal methods of preparation for study and graphic representation of this tissue by light microscopy would have taken at least 25 hours, whereas the same information has been obtained with a single 5-minute x-ray micrograph. A detailed study of the entire calvarium of the dog by light microscopy would take several months, but the same information could be obtained in a few 5-minute exposures using the x-ray microscope.

Future studies are proposed, which will include x-ray micrographic representation of the veins of the diploë in skulls of man and monkey. From the observations made thus far, there appears to be a characteristic difference between the distribution of diploic veins in the skull of the dog and that of man.

Other applications of the x-ray microscope have been made with striking results. Engstrom, Bellman, and Engfeldt (*4*) have used contact microradiography on living tissues. Bohatirchuk (*5*) was successful in studying the aging of the vertebral column with this method of microradiography. X-ray micrographs have been made of the kidney by Nixon and studies of gallstones and kidney stones have been forecast.

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References and Notes

1. W. C. Nixon, *Research (London)* **8**, 473 (1955).
2. V. E. Cosslett and W. C. Nixon, *Nature* **168**, 24 (1951).
3. W. C. Nixon and V. E. Cosslett, *Brit. J. Radiol.* **28**, 532 (1955).
4. A. Engstrom, S. Bellman, B. Engfeldt, *ibid* **28**, 517 (1955).
5. F. Bohatirchuk, *ibid.* **28**, 389 (1955).
6. This work was done while W. C. Nixon was visiting research associate at the University of Redlands under a National Science Foundation grant.

3 April 1956

We must never forget that metaphysics divides people, and science unites them.
—Philipp Frank.

Meetings and Societies

Physical Anthropologists

The 25th annual meeting of the American Association of Physical Anthropologists was held in Chicago, 6–8 Apr., under the sponsorship of the department of anthropology of the University of Chicago (S. L. Washburn, local committee chairman). Registered attendance numbered 162. The program, which comprised 42 papers and demonstrations, featured a symposium on the fossil Australopithecines of South Africa, an address on the history of the association, a panel discussion of human identification, and a supper conference on publication problems sponsored by the Wenner-Gren Foundation for Anthropological Research.

In the australopithecine symposium, Howell outlined the geologic problems in the Lower Pleistocene of Africa, Oakley (British Museum) related the consequent problems in dating to the fossil finds and the so-called "tools" found at Makapansgat, and Robinson (Transvaal Museum) dealt with the anatomical relationship of certain of the Australopithecines to the hominid stock and exhibited the most complete group of australopithecine remains yet brought to the United States. After a discussion by Davis of the ecological definition of genera in mammalian taxonomy, Goff (locomotion), Dahlberg (dentition), Coon (taxonomy), and Tobias (phylogeny) led the discussion, which tended to place the Australopithecines in the main lines of human evolution chiefly because of their bipedal locomotion and hominid teeth.

Almost one-third of the remaining papers likewise centered on human evolution or its genetics, including Fox's paper on chromatographic-technique limitations in study of genetics of dipteran races. Thus the genetic and ecological bases for human racial evolution were outlined by Lasker, Estel, Birdsell, and Thieme (blood-typing of Midland Man bone), and Tobias (Witwatersrand University) traced the evolution of the South African Bushman. Papers on distribution of the cephalic index in the Pacific (Marshall), comparison of Upper Cave (Peking) skulls with those of early Amerinds (G. Neumann), and congenital hip dysplasia in Apaches (Kraus and Schwartzmann) also bore directly on evolution, while the paper on analysis of social forces modifying breeding patterns in man (Aginsky) had indirect bearing.

The papers on structure and function included two on hand-joint anatomy (Smith, Holcomb, and Fluegel; Barter, Fry, and Truett), two on the study of stress in bone (Evans and Goff on the femur, Tappen on the growing gorilla skull), and others on posture and bone change in bipedal rats and mice (Goff and Landmesser), muscle dynamometry (Barter and Van Wart), primate laryngeal sacs as a force product of brachiation (Enzmann), and mycoses in arteriole destruction in mental-disease patients (Papez). Morphology in its relation to growth and aging processes was the theme of papers on body composition (Brozek; White; Garn and Gorman), effects of poor environment (Acheson *et al.*), aging of chronically obese women (Angel), physique of criminals (Dupertuis), and skull growth (Young). The grouping of presentations on morphological details useful in both individual and racial identification included one on hair (Duggins), three on use of the innominate bone in the determination of age (McKern) and sex (Stewart, Hoyme), and four on dental and oral details (Dahlberg, Epling, Brown, Klatsky). These were followed by R. Newman's outline of the difficulties involved in training an adequate reserve of experts in identification work of the sort needed by the armed forces. The material in all of these papers also has relevance for human evolution.

President Mildred Trotter's address at the 25th anniversary dinner highlighted the major phases and significant incidents in the association's birth and growth as a scientific organization, especially in its relationship to the older *American Journal of Physical Anthropology,* now its medium of expression. Of the 84 charter members of the association, four (Herskovits, Papez, Stewart, Trotter) were present.

More serious was the necessity at the business meeting of taking nonpolitical action regarding abuse of anthropological data on race (as recently in North Carolina) during the current dissension concerning racial "integration" as opposed to the segregation of the past in this country. Several simplifications produced the following resolution, passed overwhelmingly by the membership.

"The members of the American Association of Physical Anthropologists, meeting in Chicago, Illinois, on April 6, 1956, affirm that they know of no evidence that any group is inferior to any other group by virtue of race. They support Dr. John Gillin in his recent position in this respect."

This reference is to Gillin's clarification of Western civilization's superior material achievement as due to cultural, historical, and ecological factors rather than to genetic ones; his statement was published by the newspaper of the University of North Carolina.

BETTY L. POPE
Department of Anthropology, University of Chicago, Chicago, Illinois

Hotel Headquarters and Housing, New York Meeting

The preliminary announcement of the seventh New York meeting, 26–31 Dec., of the American Association for the Advancement of Science [*Science* **123**, 947 (1956); *Sci. Monthly* **83**, 48 (1956)], although it named the Statler as AAAS headquarters hotel, the New Yorker as headquarters for the Entomological Society of America, and the Sheraton-McAlpin as headquarters for the science teaching societies, was principally concerned with the programs of the 1956 meeting—as planned by all 18 AAAS sections and by some 44 participating societies (exclusive of another 40 organizations which will participate as official cosponsors of appropriate sessions). A list of the headquarters for each section and participating organization is appended—it is an obvious convenience for each person attending the meeting to have this information before he applies for room reservations. However, since all five "Penn Zone" hotels are within a block of Pennsylvania Station—with which three of them are connected by tunnels, and thus with each other—one hotel is almost as convenient as another.

The center of the meeting will be the Hotel Statler and here will be located the AAAS Main Registration-Information Center, the Visible Directory of Registrants, the AAAS Office, AAAS Press Room, AAAS Science Theatre, and the Annual Exposition of Science and Industry. The Statler's large ballroom and adjacent rooms will be the site of the AAAS-sponsored general symposium, *Moving Frontiers of Science,* the Council meeting and other business sessions of the Association, the AAAS Presiden-

tial Address and Reception, the special evening events, and the AAAS Smoker. With a very few exceptions, all sessions will be in the numerous public rooms of the Statler and the other Penn Zone hotels. It follows that the meeting will be a particularly convenient one in all respects.

Housing

Beginning with this issue, the advertising section of *Science* will carry, at frequent intervals, page announcements of hotel sleeping accommodations and their current rate schedules, together with a coupon which should be filled out and sent, *not* to any hotel directly, but to the AAAS Housing Bureau in New York. (Members of the American Astronomical Society, however, wishing rooms in uptown hotels, such as the Alden, should correspond directly with the Hayden Planetarium.)

All applications for hotel rooms will be filled in the order of their receipt. Those who apply early are assured of the hotel of their first choice if the stated desired and maximum rates are within the limits of the printed rate schedules. In New York's Penn Zone there is an adequate supply of rooms at a wide range of rates. It would be well to consider, however, that, as in any city, the supply of single rooms at minimum rates is relatively limited and that higher priced single rooms and double rooms for single occupancy are more plentiful. Thus, it is suggested that the *maximum rate,* which you do not wish to exceed, and your *desired rate* both be stated on your coupon. Room expenses usually can be reduced substantially if rooms are shared by two persons or if suites are shared by three or more persons. Also, upon request, most hotels will place comfortable rollaway beds in rooms or suites at $2.50 or $3.00 per night.

Registration

Both the technical or program sessions and the special sessions are open to all interested persons. Although registration for these is not mandatory, it is expected that all who attend will wish to pay the AAAS registration fee of $3.00 and thus contribute a proportionate share of the heavy expenses of the meeting. Each registrant receives the book-size General Program-Directory (a valuable reference on all AAAS activities), convention literature, listing in the Visible Directory of Registrants, and a Convention Badge, which insures all privileges of the meeting. The badge *is* required for admission to the large-scale exhibits, the AAAS Science Theatre, the Presidential Address and Reception, and the AAAS Smoker; refreshments are served at the last two events. It is planned to distribute to registrants a limited number of free radio broadcast tickets on the first days of the meeting; usually the Empire State Building's observation tower and other points of interest to which admission is charged grant discounts to registrants.

Advance registration has some decided advantages: delay at the registration desks upon arrival is eliminated; the General Program-Directory, which is sent by first class mail early in December, enables one, at leisure, to determine which events and sessions he particularly does not wish to overlook; and one's name is posted in the Visible Directory of Registrants as the meeting opens (hotel room can be added later by the registrant himself).

An announcement on advance registration and a coupon for this will also be found in the advertising section of this issue and at intervals hereafter.

Penn Zone Hotels

Note: Societies are grouped in the same sequence of disciplines as the letters of the AAAS sections.

Statler (2200 rooms), 32 and 33rd Sts. and Seventh Ave.: AAAS; Press; Exhibits; AAAS Sections C–Chemistry, F–Zoological Sciences, G–Botanical Sciences, M–Engineering, N–Medical Sciences, Nd–Dentistry, Np–Pharmacy, and P–Industrial Science; AAAS-Gordon Research Conferences, Alpha Chi Sigma; American Society of Zoologists, Herpetologists League, International Union for the Study of Social Insects, New York Zoological Society, Society of Systematic Zoology, Society of Vertebrate Paleontology; American Society of Naturalists, Ecological Society of America, Genetics Society of America, Society for the Study of Evolution, Society of General Physiologists; American Society of Plant Physiologists, Botanical Society of America, Torrey Botanical Club; Engineering Manpower Commission; Alpha Epsilon Delta, American Association of Hospital Consultants, American Medical Association Committee on Cosmetics, American Physiological Society, American Psychiatric Association; American College of Dentists, American Dental Association, International Association for Dental Research; American Association of Colleges of Pharmacy, American College of Apothecaries, American Pharmaceutical Association, Scientific Section, American Society of Hospital Pharmacists; American Association of Scientific Workers, Conference on Scientific Manpower, National Academy of Sciences-National Research Council, National Association of Science Writers, National Science Foundation, New York Academy of Sciences, Scientific Manpower Commission, Scientific Research Society of America, Sigma Delta Epsilon, Society of the Sigma Xi, United Chapters of Phi Beta Kappa.

Governor Clinton (450 rooms), 31 St. and Seventh Ave.: AAAS Sections A–Mathematics and L–History and Philosophy of Science; Association for Computing Machinery, Society for Industrial and Applied Mathematics; American Philosophical Association, History of Science Society, Philosophy of Science Association, Society for the Advancement of General Systems Theory; American Documentation Institute, Conference on Scientific Editorial Problems, National Bureau of Standards.

Sheraton-McAlpin (1500 rooms), 33 and 34 Sts. and Broadway: AAAS Sections H–Anthropology, I–Psychology, K–Social and Economic Sciences, and Q–Education; National Association of Biology Teachers; American Institute of Human Paleontology; American Political Science Association, American Sociological Society, National Academy of Economics and Political Science, Pi Gamma Mu, Society for the Advancement of Criminology; AAAS Cooperative Committee on the Teaching of Science and Mathematics, American Educational Research Association, International Council for Exceptional Children, National Association for Gifted Children, National Association for Research in Science Teaching, National Science Teachers Association; Academy Conference, American Nature Study Society.

Martinique (350 rooms), 32 St. and Broadway: AAAS Sections B–Physics, E–Geology and Geography, and O–Agriculture; American Meteorological Society, Sigma Pi Sigma; Association of American Geographers, Geological Society of America, National Geographic Society, National Speleological Society; American Society of Range Management; American Geophysical Union.

New Yorker (2200 rooms), 34 and 35 Sts. and Eighth Ave.: Entomological Society of America.

Uptown Hotels

Alden (600 rooms), 82 St. and Central Park West: AAAS Section D–Astronomy, American Astronomical Society.

Edison (869 rooms), 228 W. 47 St.: also recommended for astronomers.

Meeting Notes

■ Members of the Massachusetts Institute of Technology Rocket Research Society are requested to write to James C. Keith, president, at 14800 Ashton Road, Detroit 23, Mich., for information on how they may vote in the 1956 elections of the American Astronautical Federation. The AAF national secretary, Rinehart S. Potts, 1049 Cedar Ave., Pitman, N.J., has tentatively set 15 Sept. as the deadline for receipt of ballots. An entire new national board of directors will be elected and, later in the fall, new national officers. Member societies of the

AAF now total nine, with the recent admission of the Intermountain Rocket Society (Salt Lake City, Utah), Boise (Ida.) Rocket Research Society, Society for the Advancement of Space Travel, and the Reaction Missile Research Society (State College, N.M.).

■ "Fifty years of progress through electronics" will be the theme of the 12th annual National Electronics Conference at the Hotel Sherman in Chicago, 1–3 Oct. This year marks the golden anniversary of the electronics industry—founded in 1906 when Lee De Forest developed the audion, the first three-electrode vacuum tube. Approximately 100 technical papers and 240 commercial exhibits will be featured at the conference.

More than 10,000 persons are expected to attend the meeting, which is sponsored annually by the American Institute of Electrical Engineers, Institute of Radio Engineers, Illinois Institute of Technology, University of Illinois, and Northwestern University. Also participating in the conference are Michigan State, Purdue, Michigan, and Wisconsin universities, as well as the Radio-Electronics-Television Manufacturers Association and the Society of Motion Picture and Television Engineers. Proceedings of the 1955 National Electronics Conference now can be obtained at $5 per copy from the NEC headquarters, 84 E. Randolph St., Chicago.

■ The seventh Canadian High Polymer Forum will be held at the Guildwood Inn, Sarnia, Ont., 8–9 Nov. The forum is cosponsored by the National Research Council of Canada and the Chemical Institute of Canada. The guest speaker at the banquet on 8 Nov. will be J. J. Hermans of the University of Leiden.

Those desiring to present papers are requested to notify the program chairman, Dr. D. G. Ivey, Department of Physics, University of Toronto, Toronto 5, Ont. Abstracts and final titles must be submitted *by 31 Aug.* Room reservations and travel information may be obtained by writing to the chairman of the forum, Dr. H. Leverne Williams, Polymer Corporation Limited, Sarnia, Ont., Canada.

■ The eighth annual Midwestern Conference of Parasitologists, which was held at the State University of Iowa on 11–12 June, included 22 research demonstrations and a series of selected motion pictures. Following the annual banquet on 11 June, William Headlee of the University of Indiana Medical Center discussed general phases of his work on the epidemiology of parasitic helminths in Thailand. W. D. Lindquist, Michigan State University, presided and J. E. Ackert was elected presiding officer of the conference for the coming year.

Society Elections

■ American Society for Quality Control: pres., Dale L. Lobsinger, United Airlines; sec., L. S. Eichelberger, A. O. Smith Corporation; treas., J. Y. McClure, General Dynamics Corporation. The vice presidents are Leon Bass, General Electric Company; C. E. Fisher, Bell Telephone Laboratories; Ellis R. Ott, Rutgers University; Ervin E. Schiesel, Mattatuck Manufacturing Company. Representative to the AAAS Council is Paul S. Olmstead, Bell Telephone Laboratories.

■ American Society of Limnology and Oceanography, Pacific Section: pres., George L. Pickard, University of British Columbia; v. pres., Marston C. Sargent, Scripps Institution of Oceanography; sec.-treas., Maurice Rattray, Jr., University of Washington. Representatives to the AAAS Council are G. L. Pickard and M. Rattray, Jr.

■ American Ethnological Society: pres., Dorothy L. Keur, Hunter College; v. pres., Allan R. Holmberg; sec.-treas., Willard Rhodes, Columbia University, New York 27, N. Y.

■ American Society of Mammalogists: pres., William B. Davis, Texas A. and M. College; treas., Caroline A. Heppenstall, Carnegie Museum; rec.-sec., Randolph L. Peterson, Royal Ontario Museum of Zoology, Toronto, Canada; cor.-sec., Bryan P. Glass, Oklahoma A. and M. College, Stillwater, Okla. The vice presidents are Robert T. Orr, California Academy of Sciences, and Stephen D. Durrant, University of Utah.

Forthcoming Events

August

20–21. **Mathematical Assoc. of America, 37th summer, Seattle, Wash. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)**

20–21. **National Telemetering Conf., Los Angeles, Calif. (R. E. Rawlins, Lockheed Aircraft Corp., Burbank, Calif.)**

20–24. **Conf. on Scientific and Technical Writing, Philadelphia, Pa. (H. F. Arader, Univ. of Pennsylvania, 3400 Walnut St., Philadelphia 4.)**

20–24. **Institute of Mathematical Statistics, Seattle, Wash. (G. E. Nicholson, Jr., Dept. of Statistics, Univ. of North Carolina, Chapel Hill.)**

20–24. **International Cong. of Physical Medicine, 2nd, Copenhagen, Denmark. (S. Clemmesen, Kommune-hospitalet, Copenhagen.)**

20–24. **Plant Science Seminar, 33rd annual, St. Louis, Mo. (F. L. Mercer, St. Louis College of Pharmacy, St. Louis 10.)**

20–25. **American Mathematical Soc., 61st summer, Seattle, Wash. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)**

21–24. **Western Electronic Show and Convention, Los Angeles, Calif. (B. Angwin, General Electric Co., 11840 W. Olympic Blvd., Los Angeles 64.)**

22–29. **World Cong. of Sociology, 3rd, Amsterdam, Netherlands. (T. B. Bottomore, Skepper House, 13 Endsleigh St., London, W.C.1, England.)**

24–28. **American Astronomical Soc., joint with Astronomical Soc. of the Pacific, Berkeley, Calif. (J. A. Hynek, Harvard College Observatory, Harvard Univ., Cambridge 38, Mass.)**

26–30. **American Inst. of Biological Sciences, Storrs, Conn. (H. T. Cox, 2000 P St., NW, Washington 6.)**

The following 23 meetings are being held in conjunction with the AIBS meeting at Storrs, Conn.

26–30. **American Bryological Soc. (L. J. Gier, Dept. of Biology, William Jewell College, Liberty, Mo.)**

26–30. **American Fern Soc., annual. (Mildred E. Faust, 501 University Pl., Syracuse 10, N.Y.)**

26–30. **American Microscopical Soc. (R. W. Pennak, Dept. of Biology, Univ. of Colorado, Boulder.)**

26–30. **American Soc. for Horticultural Science, annual. (F. S. Howlett, Ohio Agricultural Experimental Station, Wooster, Ohio.)**

26–30. **American Soc. of Human Genetics. (E. J. Gardner, Dept. of Zoology, Utah State Agricultural College, Logan.)**

26–30. **American Soc. of Limnology and Oceanography, annual. (B. H. Ketchum, Woods Hole Oceanographic Institution, Woods Hole, Mass.)**

26–30. **American Soc. of Parasitologists, annual. (A. C. Walton, Knox College, Galesburg, Ill.)**

26–30. **American Soc. of Plant Physiologists, annual. (A. W. Galston, Dept. of Botany, Yale Univ., New Haven, Conn.)**

26–30. **American Soc. of Plant Taxonomists, annual. (R. C. Rollins, Gray Herbarium, Harvard Univ., 22 Divinity Ave., Cambridge 38, Mass.)**

26–30. **Biometric Soc., ENAR. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)**

26–30. **Botanical Soc. of America, annual. (H. C. Bold, Vanderbilt Univ., Nashville, Tenn.)**

26–30. **Ecological Soc. of America, annual. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)**

26–30. **Mycological Soc. of America, annual. (C. J. Alexopoulos, Dept. of Botany, Michigan State Univ., East Lansing.)**

26–30. **National Assoc. of Biology Teachers. (P. V. Webster, Bryan City Schools, Bryan, Ohio.)**

26–30. **Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)**

26–30. **Phycological Soc. of America, annual. (P. C. Silva, Dept. of Botany, Univ. of Illinois, Urbana.)**

26–30. **Soc. of General Physiologists. (A. M. Shanes, National Inst. of Arthritis and Metabolic Diseases, Bethesda 14, Md.)**

26–30. **Soc. for Industrial Microbiology, annual. (C. P. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)**

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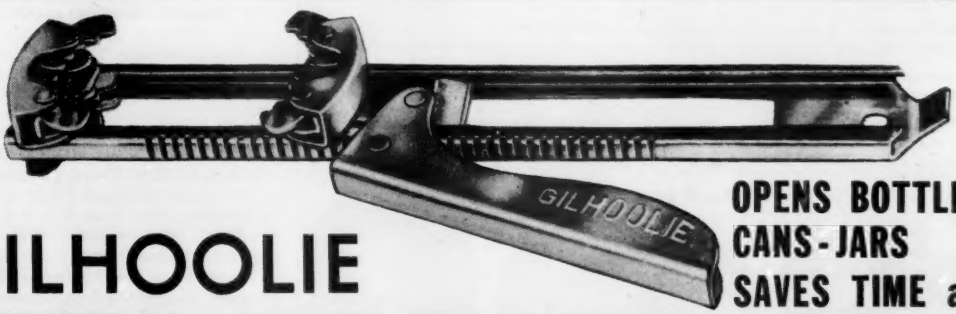

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26–30. Soc. of Protozoologists, annual. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

26–30. Soc. of Systematic Zoology. (R. E. Blackwelder, 3728 Second St. South, Arlington 4, Va.)

27–29. American Soc. of Zoologists, 53rd annual. (R. T. Kempton, Marineland Research Laboratory, Marineland, Fla.)

27–29. Genetics Soc. of America, annual. (H. B. Newcombe, Atomic Energy of Canada, Ltd., Chalk River, Ont.)

27–31. American Soc. of Naturalists, annual. (B. Wallace, Biological Lab., Cold Spring Harbor, Long Island, N.Y.)

26–1. International Soc. of Haematology, 6th cong., Boston, Mass. (ISH, New England Medical Center, Harrison Ave. at Bennet St., Boston 11.)

27–31. Biological Photographic Assoc., 26th annual, Rochester, N.Y. (BPA, c/o 343 State St., Rochester 4.)

27–31. Colloquium on Statistical Mechanics of Transport Processes, IUPAP, Brussels, Belgium. (I. Prigogine, 40 Avenue F. D. Roosevelt, Brussels.)

27–31. Infrared Spectroscopy Inst., 7th annual, Nashville, Tenn. (N. Fuson, Dept. of Physics, Fisk Univ., Nashville 8.)

28–2. Colloquium on Semiconductors and Phosphors, IUPAP, Garmisch-Partenkirchen, Germany. (H. Maier-Leibnitz, Walter-von-Dyck-Platz 1, Munich 2, Germany.)

29–5. British Assoc. for the Advancement of Science, annual, Sheffield, England. (Secretary, BAAS, Burlington House, Piccadilly, London, W.1., England.)

29–8. International Soc. of Soil Science, 6th cong., Paris. (F. A. Van Baren, ISSS, Royal Tropical Inst., Mauritskade 63, Amsterdam, Netherlands.)

30–5. American Psychological Assoc., Chicago, Ill. (F. H. Sanford, 1333 16 St., NW, Washington 6.)

30–5. Psychometric Soc., Chicago, Ill. (L. V. Jones, Dept. of Psychology, Univ. of Chicago, Chicago 37.)

September

1–9. International Cong. of Anthropological and Ethnological Sciences, 5th, Philadelphia, Pa. (Secretary, American Organizing Committee, International Cong. of Anthropology, National Acad. of Sciences–National Research Council, 2101 Constitution Ave., Washington 25.)

2–7. Laurentian Hormone Conf., AAAS, Mont Tremblant, Quebec, Canada. (Committee on Arrangements, LHC, 222 Maple Ave., Shrewsbury, Mass.)

4–5. Meteoritical Soc., 19th meeting, Bloomington, Ind. (C. W. Beck, Dept. of Geology, Indiana Univ., Bloomington.)

4–6. International Assoc. of Milk and Food Sanitarians, annual, Seattle, Wash. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

4–7. American Physiological Soc., Rochester, N.Y. (M. O. Lee, APS, 9650 Wisconsin Ave., Washington 14.)

4–9. American Ornithologists' Union, annual, Denver, Colo. (H. F. Mayfield, 2557 Portsmouth Ave., Toledo 13, Ohio.)

4–11. International Geological Cong., 20th, Mexico, D.F. (Congreso Geológico Internacional, Calle Balderas 36, Despacho 302-A, Mexico, D.F.)

4–11. International Paleontological Union, Mexico, D.F. (H. E. Vokes, Johns Hopkins Univ., Baltimore 18, Md.)

5–7. Cryogenic Engineering Conf., Boulder, Colo. (P. L. Barrick, National Bureau of Standards Cryogenic Engineering Laboratory, Boulder.

5–7. Wyoming Geological Field Conf., 11th annual, Moran, Wyo. (K. W. Frielinghausen, Box 1571, Casper, Wyo.)

5–13. International Cong. of Applied Mechanics, 9th, Brussels, Belgium. (H. L. Dryden, Director, National Advisory Committee for Aeronautics, Washington 25.)

6–8. American Political Science Assoc., annual, Washington, D.C. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

6–8. Phi Sigma Soc., Ann Arbor, Mich. (K. F. Lagler, Dept. of Fisheries, School of Natural Resources, Univ. of Michigan, Ann Arbor.)

6–12. International Genetics Symposium, Tokyo and Kyoto, Japan. (Secretary, IGS 1956 (Science Council of Japan, Ueno Park, Tokyo.)

7–9. American Sociological Soc., annual, Detroit, Mich. (Mrs. M. W. Riley, ASS, New York Univ., Washington Square, New York 3.)

7–10. American Statistical Assoc., annual, Detroit, Mich. (D. C. Riley, ASA, 1757 K St., NW, Washington 6.)

7–10. Biometric Soc., ENAR, Detroit, Mich. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

7–10. Econometric Soc., Detroit, Mich. (R. Ruggles, Dept. of Economics, Yale Univ., New Haven, Conn.)

9–12. American Inst. of Chemical Engineers, Pittsburgh, Pa. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–13. International College of Surgeons, 21st annual, Chicago, Ill. (K. A. Meyer, 1516 Lake Shore Drive, Chicago 10.)

9–14. International Cong. of Clinical Chemistry, New York, N.Y. (J. G. Reinhold, 711 Maloney Bldg., Univ. of Pennsylvania, Philadelphia 4.)

9–16. Cong. on Analytical Chemistry, Lisbon, Portugal. (P. A. Laurent, Instituto Superior Tecnico, Av. Rovisco Pais, Lisbon.)

10–12. American Soc. of Mechanical Engineers, fall, Denver, Colo. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

10–12. Electron Microscope Soc. of America, annual, Madison, Wis. (Miss J. R. Cooper, Nela Park 130, Cleveland 12, Ohio.)

10–14. European Soc. of Cardiology, 2nd cong., Stockholm, Sweden. (K. E. Grewin, Sodersjukhuset, Stockholm.)

10–14. Immunomicrobiological Standardization Symposium, 2nd, Rome, Italy. (G. Penso, Instituto Superiore di Sanita, Viale Regina Elena, 299, Rome.)

10–14. International Cong. on Catalysis, Philadelphia, Pa. (H. Heinemann, ICC, c/o Houdry Process Corp., P.O. Box 427, Marcus Hook, Pa.)

10–14. International Cong. of Dietetics, 2nd, Rome, Italy. (American Dietetic Assoc., 620 N. Michigan Ave., Chicago 11, Ill.)

10–14. International Conf. on Fatigue of Metals, London, England. (Secretary, Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1.)

13–17. Static Electricity in Textiles, Zurich, Switzerland. (General Secretary, Textile Institute, 10 Blackfriars St., Manchester 3, England.)

14–15. Calorimetry Conf., 11th annual, Baltimore, Md. (H. A. Boorse, Pupin Physics Laboratories, Columbia Univ., New York 27.)

15–22. Congreso Panamericano de Gerontología, 1st, Mexico, D.F., Mexico. (E. V. Cowdry, Washington Univ. School of Medicine, St. Louis 10, Mo.)

16–21. American Chemical Soc., Atlantic City, N.J. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

16–22. American Soc. for Testing Materials, Pacific Coast meeting, Los Angeles, Calif. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

17–21. Illuminating Engineering Soc., annual, Boston, Mass. (A. D. Hinckley, IES, 1860 Broadway, New York 23.)

17–21. Instrument Soc. of America, 11th international conf., New York, N.Y. (F. J. Tabery, 250 W. 57 St., New York 19.)

17–23. European Confederation of Agriculture, 8th general assembly, Sheveningen, Netherlands. (M. Collaud, ECA, Pestalozzistrasse 1, Brugg, Argovie, Switzerland.)

19–23. International Cong. of Internal Medicine, 4th, Madrid, Spain. (C. Jimenez Diaz, Facultad de Medicina, Madrid.)

21–22. Pharmacotherapy in Mental Illness, Washington, D.C. (J. O. Cole, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

24–26. American Oil Chemists' Soc., Chicago, Ill. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Drive, Chicago 1.)

24–26. Biochemistry of Lignin, 3rd round table, Appleton, Wis. (H. F. Lewis, Inst. of Paper Chemistry, Appleton.)

24–28. International Dairy Cong., 14th, Rome, Italy. (R. E. Hodgson, Dairy Husbandry Research Branch, U.S. Dept. of Agriculture, Beltsville, Md.)

25–27. Atomic Industrial Forum and Trade Fair, 3rd annual conf., Chicago, Ill. (C. Robbins, AIF, 260 Madison Ave., New York 16.)

25–28. American Roentgen Ray Soc., annual, Los Angeles, Calif. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

25–28. Assoc. of Iron and Steel Engineers, annual, Cleveland, Ohio. (Secretary, AISE, Empire Bldg., Pittsburgh 22, Pa.)

26–28. Mississippi Valley Medical Soc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

26–29. European Cong. of Allergology, 3rd, Florence, Italy. (U. Serafini, Instituto di Patologia Medica, Viale Morgagni, Florence.)

27–30. Alaskan Science Conf., 7th annual, Juneau. (H. C. Baltzo, U.S. Fish and Wildlife Service, Juneau.)

28–29. American Medical Writers' Assoc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

30. American College of Dentists, annual, Atlantic City, N.J. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis, Mo.)

30–4. Electrochemical Soc., Cleveland, Ohio. (H. B. Linford, 216 W. 102 St., New York 25.)

October

1–2. American Soc. of Photogrammetry, semiannual, Denver, Colo. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

1–3. National Electronics Conf., 12th annual, Chicago, Ill. (NEC, 84 E. Randolph St., Chicago 1.)

1–4. American Dental Assoc., annual, Atlantic City, N.J. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago 11, Ill.)

1–4. Semiconductor Symposium, Cleveland, Ohio. (M. F. Lamorte, Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.)

1–5. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

1–5. International Cong. on Medical Records, 2nd, Washington, D.C. (Miss G. L. Perkins, American Assoc. of Medical Record Librarians, 510 N. Dearborn St., Chicago 10, Ill.)

8–10. National Clay Conf., 5th, Urbana, Ill. (R. E. Grim, Univ. of Illinois, Urbana.)

8–12. American College of Surgeons, 42nd annual clinical cong., San Francisco, Calif. (ACS, 40 E. Erie St., Chicago 11, Ill.)

8–12. International Decennial Review Conf. on Tissue Culture, Woodstock, Vt. (P. R. White, Jackson Memorial Laboratory, Bar Harbor, Me.)

8–12. National Metal Cong., 38th annual, Cleveland, Ohio. (American Inst. of Mining, Metallurgical and Petroleum Engineers, 29 W. 39 St., New York 18.)

8–12. Pan-American Federation of Engineering Societies, 4th convention, Mexico, D.F., Mexico. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

8–13. International Cancer Cytology Cong., Chicago, Ill. (A. H. Dearing, College of American Pathologists, Prudential Plaza, Chicago 1.)

9–10. Air Research and Development Command Science Symposium (classified), 4th annual, Boston, Mass. (Headquarters, ARDC, U.S. Air Force, P.O. Box 1395, Baltimore 3, Md.)

9–12. American Dietetic Assoc., 39th annual, Milwaukee, Wis. (Mrs. T. Pollen, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

9–15. World Medical Assoc., 10th general assembly, Havana, Cuba. (L. H. Bauer, WMA, 345 E. 46 St., New York, N.Y.)

11–12. International Scientific Radio Union, U.S. National Committee, Berkeley, Calif. (J. P. Hagen, 2101 Constitution Ave., NW, Washington 25.)

14–17. Society of American Foresters, Memphis, Tenn. (H. Clepper, SAF, 17th and Pennsylvania Ave., NW, Washington 6.)

14–19. American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Ave. Bldg., Rochester, Minn.)

15–17. Assoc. of Official Agricultural Chemists, annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

15–17. Soil Conservation Soc. of America, Tulsa, Okla. (H. W. Pritchard, SCSA, 1016 Paramount Bldg., Des Moines, Iowa.)

15–18. American Veterinary Medical Assoc., annual, San Antonio, Tex. (J. G. Hardenbaugh, AVMA, 600 S. Michigan Ave., Chicago 5, Ill.)

15–26. New York Acad. of Medicine, annual graduate fortnight, New York, N.Y. (Secretary, Graduate Fortnight, NYAM, 2 E. 103 St., New York 29.)

16–17. National Acad. of Economics and Political Science, Washington, D.C. (D. P. Ray, George Washington Univ., Washington 6.)

16–18. Conference on Magnetism and Magnetic Materials, Boston, Mass. (T. O. Paine, Measurements Laboratory, General Electric Co., West Lynn, Mass.)

17–19. Symposium on Antibiotics, 4th annual, Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Administration, U.S. Dept. of Health, Education, and Welfare, Washington 25.)

18–20. Optical Soc. of America, semiannual, Lake Placid, N.Y. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

21–23. American College of Apothecaries, Dallas, Tex. (R. E. Abrams, Hamilton Court, 39th & Chestnut St., Philadelphia 4, Pa.)

21–27. Iberian-Latin American Cong. of Dermatology, 3rd, Mexico City, Mexico. (Centro Dermatológico Pascua, Calle Dr. Garciadiego 21, Mexico 7, D.F.)

22–25. American Soc. for Pharmacology and Experimental Therapeutics, Louisville, Ky. (H. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

22–26. National Safety Cong., Chicago, Ill. (R. L. Forney, National Safety Council, 425 N. Michigan Ave., Chicago, 11.)

23. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

25–26. National Soc. of Professional Engineers, White Sulphur Springs, W.Va. (P. H. Robbins, 2029 K St., NW, Washington 6.)

26–29. American Heart Assoc., annual, scientific sessions, Cincinnati, Ohio. (Medical Director, AHA, 44 E. 23 St., New York 10.)

29–1. Society of Exploration Geophysicists, annual, New Orleans, La. (G. A. Grimm, Tide Water Associated Oil Co., Box 2131, Midland, Tex.)

31–2. Geological Soc. of America, annual, Minneapolis, Minn. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

Equipment News

■ TECHNICAL DATA on thermistors and varistors are contained in a catalog published by Victory Engineering. The catalog includes electric and physical characteristics covering bead, disk, rod, and washer-type thermistors, varistors, thermistor assemblies, varistor assemblies, and special products such as thermistor hypodermic needles, combustion analyzers, and gas analysis cells for vapor-phase chromatography and other uses. (Victory Engineering Corp., Dept. Sci., 54 Springfield Rd., Union, N.J.)

■ SCINTILLATION DETECTOR features a preamplifier circuit that permits its use with quarter-volt scalers and ratemeters or gamma-ray spectrometer systems. The probe-type instrument, designed for medical, biologic, and physical research where gamma-emitting radioisotopes are used, also contains a gamma-sensitive sodium iodide crystal, 6292 photomultiplier, magnetic shielding, and a detachable nose-piece collimator. The preamplifier provides a gain of 10 with negative output for use with a normal scaler or ratemeter and a gain of 2 with cathode-follower output for use with a spectrometer. Bandwidth is sufficient for 1-μsec resolution. Over-all detection efficiency is 50 percent for iodine-131 and 45 percent for cobalt-60. Background is less than 200 count/min when the instrument is used with scaler or ratemeter and 2 to 25 count/min when it is used with a gamma-ray spectrometer system that is set on isotope photopeak (depends on window-width setting). (Nuclear Instrument and Chemical Corp., Dept. Sci., 229 W. Erie St., Chicago 10)

■ CAPILLARY TUBE RACK holds essentials for microhematocrit procedures—24 capillary tubes, hemolets, and a vial for capillary tubes. The rack contains 24 wells for unsealed tubes in upright position and 24 pairs of grooves for sealed tubes in horizontal position. (American Hospital Supply Corp., Dept. Sci., Evanston, Ill.)

■ DATA PROCESSING SYSTEM, using 12-decimal digit numbers, is capable of 11,000 additions, 2000 multiplications, or 13,000 comparisons per sec. The electronic system's high-speed internal "memory" may be supplemented with up to 10 magnetic drum storage units, each having a 12-million-decimal digit capacity, and a 4-msec access time. Multiple tape units provide enlarged additional lower-speed storage. Input-output consists of punched cards, line printer, high-speed paper tape, and electric typewriter, as required. Operating strictly in decimal mode, the instrument is constructed on the modular principle, allowing compatible expansion for increasing data-processing requirements. (Logistics Research, Inc., Dept. Sci., Redondo Beach, Calif.)

■ RADIATION SURVEY METER makes possible direct readings of x-ray, gamma, and beta radiations ranging from 3.0 to 3000 mr/hr on a single scale. The time constant of the portable logarithmic survey meter is inversely proportional to radiation intensity. A one-tube circuit provides an accuracy of ± 20 percent throughout the entire range, and a built-in current source eliminates the need for radioactive sources for calibration. (Atomic Instrument Co., Dept. Sci., 84 Massachusetts Ave., Cambridge 39, Mass.)

■ VOLTAGE REGULATOR provides 0.05 percent accuracy of stabilization. The regulator circuit comprises an autotransformer that is controlled by a saturable reactor. The output is held to 220 v regardless of changes in input line voltage or output current demand. (North American Philips Co., Inc., Dept. Sci., 750 S. Fulton Ave., Mount Vernon, N.Y.)

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POSITIONS WANTED

Biochemist, Ph.D. 1952. Research experience on enzyme synthesis, drug resistance, experimental pathology. Box 179, SCIENCE. X

Botanist, Plant Physiologist, M.A., Ph.D. summer 1956, woman, Canadian, experience in lecturing elementary botany, demonstrating biology, plant physiology. Desires teaching position in these or related fields. Available for interview at Storrs. Box 176, SCIENCE. 7/20, 27

Chemist; Ph.D.; 7 years as senior chemist and production superintendent in industry; 5 years as director of research, pharmaceutical company. Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

POSITIONS WANTED

Pathologist, 40. Certified clinical and anatomical pathology. Associate Professor. Extensive surgical pathology and cancer research. More than 50 publications. Pennsylvania, Florida, California licenses. Category IV. Box 161, SCIENCE. 7/6, 13, 20

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POSITIONS OPEN

Assistant Professor of Anatomy: Ph.D. or M.D. State medical school, Southwest. Opening for histological-embryologist with research interests. Ample time and facilities for investigative work. Salary dependent on past record. Box 162, SCIENCE. X

Bacteriological Technician, interesting work, 40-hour week, no night calls. Pleasant environment, air-conditioned. Write Personnel, Children's Hospital, Cincinnati 29, Ohio. 7/6, 13, 20

Instructorship for 1956–57 in a small liberal arts college in central New York. To teach general botany and general bacteriology and assist with another course. Box 175, SCIENCE. 7/20

POSITIONS OPEN

Clinical Investigation—Opportunity for interesting career dealing with new medical developments of front-rank ethical pharmaceutical house located Midwest. Desired qualifications: American training and licensure, background in basic research or Board qualified, age below 40. Apply Box 178, SCIENCE. 7/27

(a) **Faculty members** in anatomy, bacteriology, chemistry, microbiology, physiology, immunology, immunochemistry, virology, ecology, mathematics, physics, pharmacology, microbial physiology. (b) **Assistant director,** excellently equipped laboratories for scientific criminal investigation; Ph.D., trained in physiology, pharmacology, human anatomy, pathology. (c) **Analytical chemist;** control department, pharmaceutical company; $7800; West. (d) **Medical director;** medical advertising agency. (e) **Physician or Ph.D. in microbiology or biochemistry;** duties principally research; $12,000; West. (f) **Chief biochemist** affiliated university medical school; capable of initiating and coordinating research program both on clinical and basic level; $7500–$8900; South. S7-3 Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

Opening for **Fish and Crab Culturist** with Comm. of Tidewater Fisheries in Annapolis. Requires bachelor's degree in biology or biochemistry, and 3 years' experience in fisheries biology work or biochemistry work; or master's degree and 1 year's experience. Salary $5021–$6021 with increase of $260 on or after 1 Oct. File application by 31 July with Commissioner of Personnel, 31 Light St., Baltimore 2, Md. X

PERSONNEL PLACEMENT

POSITIONS OPEN

Ph.D. with Research Background in Agriculture, B.S. in entomology or plant pathology; to head research with privately owned agricultural chemical concern. Give biographical sketch. Salary open. P.O. Box 727, Salinas, Calif. 7/13, 20, 27

Pharmacologist—Research division of prominent pharmaceutical manufacturer has opening for pharmacologist to conduct research on the pharmacodynamic action of drugs. Salary commensurate with training, experience, and ability. Eastern location. In reply state age, education, experience, and salary desired. Our staff knows of this advertisement. Box 174, SCIENCE. 7/20, 27; 8/3

POSITIONS OPEN

Openings at B.S., M.S., and Ph.D. levels for **theoretical and experimental physicists** interested in reactor physics. Atomic power research laboratory offers wide variety of challenging work. Write: Mr. A. M. Johnston, Dept. C-38, Westinghouse Bettis Plant, P.O. Box 1468, Pittsburgh 30, Pa. X

Spectroscopist Analyst: Research analytical laboratory of East Coast pharmaceutical manufacturer seeks Ph.D. in chemistry; 25–35, with several years' postdoctoral experience, qualified in both ultraviolet and infrared spectroscopy and preferably with experience in chemical analysis. Liberal benefit program. Send complete personal data. Box 173, SCIENCE. 7/20, 27; 8/3

POSITIONS OPEN

Statisticians for statistical group at atomic power laboratory. Will serve as consultants to engineers, physicists, chemists, and metallurgists in the design of experiments. Requires a minimum eduational level of master of science degree with a broad theoretical background in statistics. Write: Mr. A. M. Johnston, Dept. C-39, Westinghouse Bettis Plant, P.O. Box 1468, Pittsburgh 30, Pa. X

Writers, for free lance writing in anthropology, biology, geology, and natural history. Ph.D. or equivalent training. Experienced writers only. Send background details. Box 158, SCIENCE. 7/6, 13, 20

The MARKET PLACE

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GET YOUR ADVANCE COPY

of the General Program-Directory of the AAAS New York Meeting by first class mail – early in December

The General Program-Directory of the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

Program content

1. The two-session general symposium, "Moving Frontiers of Science," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Details of the anniversary celebrations of the AAAS-Gordon Research Conferences, Botanical Society of America, Freud *et al.*
4. Programs of the 18 AAAS sections (symposia and contributed papers).
5. Programs of the more than 80 participating societies.
6. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, RESA, Sigma Xi.
7. Details of the Hotel Statler—center of the Meeting—and other hotels and session sites.
8. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
9. Exhibitors in the 1956 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1956.
2. Complete roll of AAAS presidents and their fields.
3. The more than 265 affiliated organizations.
4. Historical sketch and organization of the Association; the 1955 revised Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

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Advance registration has these decided advantages: 1)You avoid delay at the Registration Center upon arrival; 2)You receive the General Program-Directory in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3)Your name is posted in the Visible Directory as the Meeting opens.

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Please mail this Coupon and your check or money order for $3.00 or $2.00 to the
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APPLICATION FOR HOTEL RESERVATIONS

123rd AAAS MEETING

New York City, December 26-31, 1956

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. (Members of the American Astronomical Society who wish reservations at uptown hotels should correspond directly with the Hayden Planetarium.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 20, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
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New Yorker	7.00–10.00	10.00–14.00	11.50–17.00	25.00 and up
Sheraton-McAlpin	6.75– 9.75	9.75–12.75	10.75–13.75	20.00 and up
Statler	8.00–12.00	11.00–15.00	11.50–18.00	31.00–33.00

* Subject to 5% New York City tax on hotel rooms.

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Please reserve the following accommodations for the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
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NAME .....
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ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

RARE EARTHS AS CATALYSTS

An application which offers intriguing possibilities

a report by LINDSAY

EVER tried to burn a cube of sugar? It can't be done, you know—unless you use a catalyst . . . in this case cigarette ashes. Dust the cube with ashes, apply a match and presto—you have a junior inferno.

Of course, you're not vitally interested in burning cubes of sugar—aside from amazing your non-technical friends. We mention this little experiment to focus attention on the use of rare earths as catalysts.

Cerium and cerium oxide are being used for this purpose in several industries. And it is highly probable that among the other rare earths, you will find some that have important commercial possibilities in your operations.

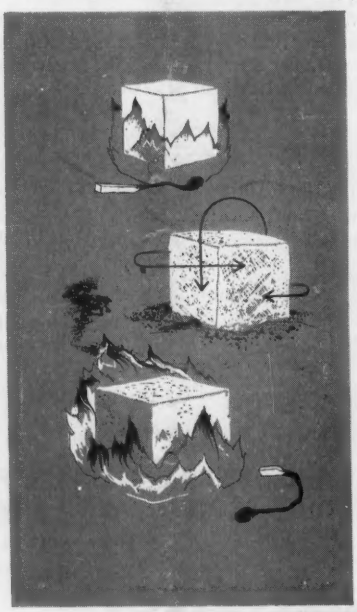
Interest in the rare earths as catalysts is gaining momentum. Although we, at Lindsay, do not make catalysts ourselves, we do supply rare earth materials for this use. Here are some of the operations where rare earths may have a place in your industry. *Ammonia Synthesis and Oxidation, Combustion and Oxidation, Dehydration, Dehydrogenation and Hydrogenation, Fischer-Tropsch Reaction, Halogenation, Methanol Synthesis, Polymerization, Crude Oil Cracking, Paint Driers.*

If any of these processes play a part in your plant operations, you may find it richly rewarding to investigate rare earths as catalysts.

This is only one of the many, many applications of these unique metals. Here at Lindsay, we have been refining and developing rare earths for over 50 years and almost every day we hear of new uses for them. Scientists in more and more industries are turning to the rare earths in their search for ways to improve their products and processes.

Take Lindsay's cerium oxide, for example. It has revolutionized glass polishing practices and is also used in colorizing and decolorizing glass.

Lindsay's rare earth chloride (a natural mixture of the chlorides of cerium, lanthanum, neodymium and praseodymium and some other rare earths) is used extensively in the textile industry, the metal industry and in the manufacture of paint and ink.



You'd be surprised at the diverse uses of rare earths in today's industrial technology. It seems as if every time you turn around, some researcher has found a new and practical application for one or more of these amazing metals. That's why we would like to suggest that you look at the rare earths with an eye toward their use as catalysts in your operations.

Some technical people have tended to overlook the rare earths, believing them to be unavailable in commercial quantities. This is not true. Lindsay is engaged in large scale production of cerium, rare earth and thorium chemicals, and offers them for prompt shipment in quantities from a gram to a carload.

To aid you, the accumulated data and the advice of Lindsay's technical staff is at your service. Your inquiry is invited.

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